Prerequisites: Significant Figures + Units: Student Review Notes

Rules for Significant Figures

1. **All non-zero digits are significant.** For example
   1247 cm has 4 sig. figs.
   432 g has 3 sig. figs.

2. **Zeros between non-zero digits are significant.** For example
   1007 cm has 4 sig. figs.
   402 g has 3 sig. figs.

3. **Zeros beyond the decimal point, at the end of the number are significant.** For example
   1.700 cm has 4 sig. figs.
   402.0 g has 4 sig. figs.

4. **Zeros preseeding the first non-zero digit in a value are <u>not</u> significant.** For example
   0.700 cm has 3 sig. figs.
   0.0076 g has 2 sig. figs.

**** Note:** scientific notation only expresses significant figures and therefore converting numbers to scientific notation helps counting sig. figs. For example:

450 cm has how many sig. figs.? Well, the way it is expressed here is ambiguous. It could mean:
450 ± 10 (2 sig. figs.)
or, 450 ± 1 (3 sig. figs.)
What you want to do is use scientific notation to avoid this ambiguity.
4.5×10^2 (2 sig. figs.)
4.50×10^3 (3 sig. figs.)

Computations

Rule of Thumb: The accuracy of the result of a calculation cannot exceed the accuracy of any individual measurement used in the calculation.

Multiplication & Division: The number of sig. figs. in the result must be the same as that of the measurement with the fewest sig. figs. For example here is a calculation of density given mass and volume measurements:

mass = 3.129 g
volume = 2.06 L

$$\text{density} = \frac{m}{V} = \frac{3.129}{2.06} = (1.518932)$$ ← Your calculator doesn't know about sig. figs

The mass measurement has 4 sig. figs. The volume measurement has 3 sig. figs. The ratio of the two should therefore have 3 sig. figs.--the same as the number with the fewest sig. figs. Make sure to round accordingly.

density = 1.52 g/L

Addition & Subtration: The number of digits beyond the decimal point in a result must be the same as that in the measurement with the fewest number of digits beyond the decimal point. i.e. you can't end up with at result that is more accurate than the least accurate measurement. Again, you need to round accordingly. For example:

$$\begin{array}{r} 10.21 \\ +\ 8.0054 \\ \hline 18.22 \end{array}$$

Exact Numbers: Not all numbers have uncertainty (they are not representing measurements). Some values are exact. This includes: integers like, the number of people in a room and conversion factors within the same unit system, like, 1 m = 100 cm or 1 cm = 10 mm or 1000 mL = 1 L.

Units

Rule of Thumb: Most numbers in chemistry calculations represent measurements and therefore need units. **You have to keep track of units during a calculation and report your answer with units**.

There are two unit systems primarily used in chemisty with the metric system used most often:

MKS: This system is based on meters, m (length), kilograms, kg (mass), liters, L (volume), seconds, s (time), Kelvin, K (absolute temperature) and Amperes, A (current). The derived units include:

- Force = (mass x acceleration = mass x length/time^2) = (kilogram)(meter)/(second^2) = netwon, N
- Pressure = (force/area) = (newton)/(meter^2) = pascal, Pa
- Energy = (force x length) = (newton)/(meter) = joule, J
- Power = (work/time) = (joule)/(second) = watt, W

cgs: This system is based on centimeter, cm (length), grams, g (mass), cubic-centimer, cc (volume), seconds, s (time), Kelvin, K (absolute temperature). The derived units include:

- Force = dyne = 10^{-5} N
- Pressure = barye = .1 Pa
- Energy in the form of heat= calorie = 4.187 J
- Energy in the form of work = = erg = 10^{-7} J

Unit Conversions

You'll often need to convert from one set of units to another. This is just an easy alebraic manipulation based on the use of conversion factors.

Conversion factors are ratios of equivalent values in different unit systems. Since they are equivalent, the value of the ratio is 1 and that is why you can multiply any number by a conversion factor and not change its value--you are multiplying by 1.

The best way to do this is set it up as a product and cancel units until you get to the one you want. For example:

Convert 16 meters to inches. The converstion factor = $\dfrac{39.37\ \text{in.}}{1\ \text{m}}$

$$16\ \text{m}\ \frac{39.37\ \text{in.}}{1\ \text{m}} = (629.92)\ \text{in} = 6.3 \times 10^2\ \text{in.}$$

Remember Sig. Figs.

Also, you'll often have to do this in series to get from one unit to another using a number of conversion factors.
For example, convert 27 days into seconds.

Exact

$$27\ \text{days}\ \frac{24\ \text{hours}}{1\ \text{day}}\ \frac{60\ \text{min.}}{1\ \text{hour}}\ \frac{60\ \text{s}}{1\ \text{min.}} = (2{,}332{,}800)\ \text{s} = 2.3 \times 10^6\ \text{in.}$$

2 significant figures

Here is another one. Given 1 m = 39.37 in. and 1 mile = 5280 ft, how many miles is a 12.5 km run?

Exact

$$12.5\ \text{km}\ \frac{1000\ \text{m}}{1\ \text{km}}\ \frac{39.37\ \text{in.}}{1\ \text{m}}\ \frac{1\ \text{ft}}{12\ \text{in.}}\ \frac{1\ \text{mile}}{5280\ \text{ft}} = 7.77\ \text{miles}$$

3 significant figures