Note 1d Significant Digits

Scientific Notation

Using scientific notation is the best way to show the number of significant digits. There are two parts to this notation, the mantissa and the exponent. Here is an example.

$$1.234 \times 10^{56}$$

The digits 1.234 are the mantissa. The digits 56 are the exponent. The mantissa contains the exact number of significant digits. In this case, there are four significant digits. The exponent tells you how many spaces to shift the decimal point.

If the mantissa had the same value but six significant digits, the number would be

$$1.23400 \times 10^{56}$$

The number

$$0.0000123 = 1.23 \times 10^{-5} = 12.3 \times 10^{-6} = 12.3\ \mu$$

The last representation is for convenience. It is easier to talk about 12.3 of something rather than 0.0000123 of something. Since there are prefixes to only exponents at powers of 3, we have to shift it to one of those powers.

How Many Significant Digit Do I Use in Calculations from Problems

The answer depends on how much error are you willing (or allowed) to have due to rounding. In general, if you want to have three significant digits given the known values are exact. You should retain about five digits. Rounding at the 6th digit should not affect the 3rd.

How Many Significant Digit Do I Use in Calculations from Data

The answer here is a bit different. Let's look at two examples.

Here is a set of 20 data points of the same measurement. Note that the data contain two significant digits. This means we **don't know** what the third digit is. The number of significant digits is two.

0.68	0.67	0.78	0.72
0.69	0.68	0.79	0.72
0.71	0.68	0.79	0.75
0.74	0.69	0.81	0.78
0.76	0.69	0.81	0.78

The average and the estimated standard error are

0.74	0.01

This average has the same number of significant digits as the source data. The estimated standard error has the same number of digits after the decimal as the average because we still don't know what the third digit is.

There are times when the variations in the data are small. Here is a set of data where the values are much closer together.

0.68	0.70	0.70	0.71
0.69	0.70	0.70	0.72
0.69	0.70	0.71	0.72
0.69	0.70	0.71	0.72
0.70	0.70	0.71	0.72

The average and the estimated standard error as calculated previously are

0.70	0.00

Since your measurements are very close together, the effective number of significant digits has increased. Because the measurements are close together, you can be more certain about the consensus value (the average).

The average and the estimated standard error in this case are

0.704	0.003