

Lesson 3: Significant Digits

Scientists take the ideas of precision and accuracy very seriously.

- You can actually take entire courses in University that show how to figure out the precision and accuracy of measurements.
 - Guess what? I took 'em!... your opinion of me has probably slipped a few notches ;)
- We need to know that when another scientist reports a finding to us, we can trust the accuracy and precision of all the measurements that have been done.
- A set of guidelines is needed while we do calculations so that we get rid of all those “4.243956528452940472” kind of answers you see on your calculator.
- The guidelines are there so we will know how many digits we should round off the final answer to show the correct precision.

All of this boils down to something called “**Significant Digits**”, more commonly referred to as **Sig Digs**.

Counting Sig Digs

To determine how many significant (*important*) digits a number has, follow these rules:

1. The numbers 1 to 9 are **always** sig digs.
2. Zero ("0") is a sig dig if it comes to the right of a number between 1 and 9.

Example 1:

53.862 ► Five sig digs. All the numbers are digits between 1 and 9.

1.304 ► Four sig digs. The zero counts because it appears to the right of the "3"

576.00 ► Five sig digs. The zeros count because they appear to the right of the "6"

0.0008 ► One sig dig. The zeros don't count, because they are to the left of the non-zero digits.

13 000 ► Five sig digs. But what if we meant only “about thirteen thousand?” Then we could write it differently as...

1.3×10^4 ► Two sig digs. We haven't reviewed scientific notation yet, but this is one thing it is good for. Only the first numbers (**not** the $\times 10$ to the whatever) count for sig digs.

Warning!

Some text books will tell you that the last number 13 000 number only has two sig digs, and that the zeros are “ambiguous” (a fancy way of saying “iffy”). Sure, it is unlikely that your answer will come out to exactly 13 000, but it could happen. And if those zeros were not significant we would have used a different way to write down the number like 1.3×10^4 (see the next lesson on scientific notation). We will simply follow the rule and say that it has five sig digs since those zeros are all appearing to the right of a non-zero digit.

Multiplication & Division

When you multiply or divide numbers, check which number has the fewest sig digs. Round off your answer so it has that many sig digs.

Example 2:

$$4.56 \times 13.8973 = ?$$

Putting this into a calculator you will get something like 63.371688. We round off our final answer to 63.4 (which has three sig digs), because "4.56" has the fewest sig digs... three sig digs.

Addition & Subtraction

When you **add** or **subtract** numbers, always check which of the numbers is the **least precise** (least numbers after the decimal). Use that many decimals in your final answer.

Example 3:

$$11.623 + 2.0 + 0.14 = ?$$

If you type this on a calculator, you'll get 13.763. Round it off to a final answer of 13.8, since the number "2.0" is the least precise... it only has one sig dig after the decimal.

We do this because we can't really trust how much rounding off might have been done for any decimals after this.

Your Data Sheet & Conversions

You'll see that there are a bunch of **constants** on the back of your data sheet. These are all given as three sig digs, so treat them as three sig dig numbers.

- Just because a number is on your data sheet does not mean it is somehow magically perfect.
- Each of those values was measured using experiments, and will have errors.
 - e.g. gravity is measured as 9.81 m/s^2 , which has three sig digs. That is actually the average gravity across Alberta.

You'll also notice that some **formulas** already have numbers in them, like the "2" in $v_f^2 = v_i^2 + 2ad$. These numbers are considered perfect and can be considered to have an infinite number of sig digs.

- Don't do any rounding off for those numbers. Do your rounding based on the other numbers that **you** substituted into the formula.

There are also situations where you might need to **convert** a number from one set of units to another.

- For example, 1 minute = 60 seconds. This doesn't mean that 1 minute "sort of" equals 60 seconds... it is a perfect conversion, so it also has an infinite number of sig digs.
 - Converting 2.6841 minutes in to seconds...

$$2.6841 \text{ min} \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 161.05 \text{ s}$$

- This is also true if you do a conversion of a number to use something like grams in kilograms, or to show scientific notation. After the conversion, you still have the same number of sig digs.
 - Converting 400g (3 sig digs) into kilograms gives you 0.400kg (still 3 sig digs).
 - I need to show 8631 (4 sig digs) in scientific notation, it will be $8.631\text{e}3$ (still 4 sig digs)

*** Unless you are doing it to actually round off and show a different number of sig digs ***