Notes on Significant Figures, Units and Other Important Items

IT IS ESSENTIAL TO USE APPROPRIATE UNITS

"My shoes cost 75"	is incomplete.
"My shoes cost 75 minutes"	makes no sense.
"My shoes cost 75 dollars"	makes sense.
"My shoes cost 75 cents"	makes sense.

There is a big difference between the last two examples!

Significant Figures

Whenever we make a measurement, its accuracy is dependent on the instrument used. A top-loading balance may tell us a quarter weighs 4.39 g (three significant figures) while an analytical balance tells us the same coin weighs 4.3874 g (five significant figures)

All non-zero digits in a number are significant.

Zeroes are significant when:

- There are non-zero digits before and after the zero.
  e.g. 206 has three significant figures
  20006 has five significant figures
- There are both non-zero digits and the decimal before the zero.
  e.g. 26.0 has three significant figures
  26.000 has five significant figures
- There are non-zero digits before the zero and the decimal is drawn after the zero.
  e.g. 260. has three significant figures (represented more clearly as 2.60×10^2)
  26000. has five significant figures (represented more clearly as 2.6000×10^4)

Zeroes are not significant when:

- There are no non-zero digits before the zero.
  e.g. 0.26 has two significant figures (2.6×10^{-1})
  0.00026 has two significant figures (2.6×10^{-4})

It is not clear whether or not zeroes are significant when:

- There are non-zero digits before the zero but the decimal is not drawn.
  e.g. 260 may have two or three significant figures (use scientific notation to clarify whether the number is intended to be 2.6×10^2 or 2.60×10^2)

Because a calculated value can be no more accurate than the least accurate measurement used in calculating it, there are rules for determining how many sig. fig. it should have.

- When **adding** or **subtracting** measured values, the final answer has the **same number of decimal places** as the least accurate measurement.

e.g.			
	6.28	12	1002
	+ 9.6	- 3.1	- 1000.03
	15.9	9	2

- When **multiplying** or **dividing** measured values, the final answer has the **same number of significant figures** as the least accurate measurement:

e.g.			
	6.28	12	1002
	× 9.6	÷ 3.1	÷ 1000.03
	60	3.9	1.002

Measured vs. Exact Numbers

exact numbers are quantities you can count (things which cannot reasonably be cut in half)

e.g. number of atoms, cats, students, desks, etc.
coefficients in a balanced reaction equation
all conversion factors (e.g. exactly 60 seconds in 1 minute)

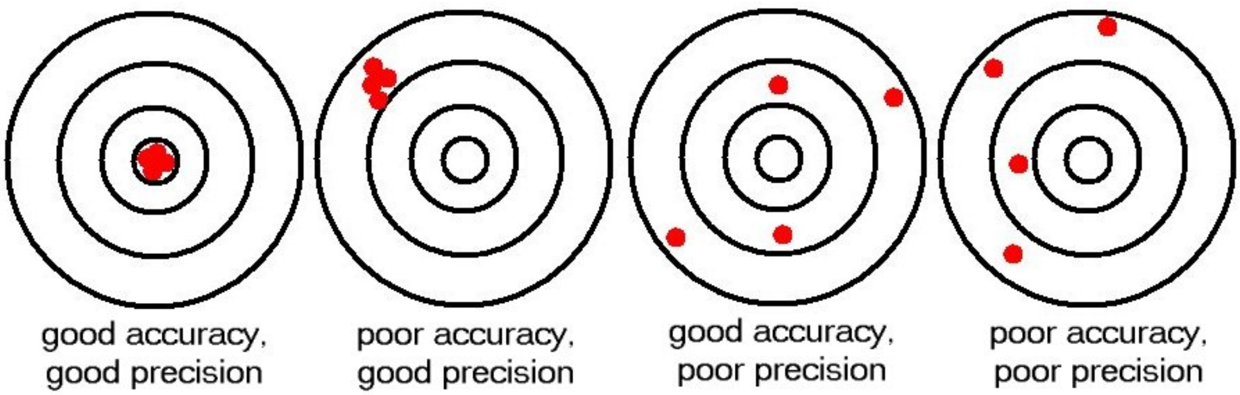
measured numbers are quantities you can measure (which can reasonably involve decimals)

e.g. length, width, mass, temperature

> Only **measured** numbers should be factored in when determining significant figures. (Exact numbers are considered to have an infinite number of significant figures.)
> When using constants, always use a value with enough significant figures so that the constant does not dictate the number of significant figures in your answer.
> **DO NOT ROUND UNTIL THE FINAL ANSWER**. If you have trouble keeping track of the correct number of significant figures, underline them as you go.

Precision and Accuracy

When you make a set of measurements, they may be accurate, precise, both or neither:



Accuracy refers to how close the average measurement is to the 'correct' value. You can only know how accurate you were *if* you know the right answer. Calculation of **percent error** is a technique you will use in lab to report a measurement's accuracy.

Precision refers to how close the measurements are to each other (or how close each measurement is to the average). You can know how precise you were without knowing the right answer. Calculation of **standard deviation** is a technique used to report a measurement's precision.