Our classroom experiment: Results

Mass (g)
7.1218
7.1219
7.1217
7.1218
7.1218
7.1218
7.1219
7.1218
7.1217
7.1219

Sum of pts= 71.2181 g
Number pts= 10
Average 7.12181 g

Overall average

7.1218 g (± 0.0001 g)

Certain digits: Little or no variation between mesaurements

Uncertain digit: Expected to vary by +/- 1 (or more) in repeated measurements

When reading measurements from a scale, record all CERTAIN digits and one UNCERTAIN (or estimated) digit.

When reading a digital scale, include all digits reported by the device.

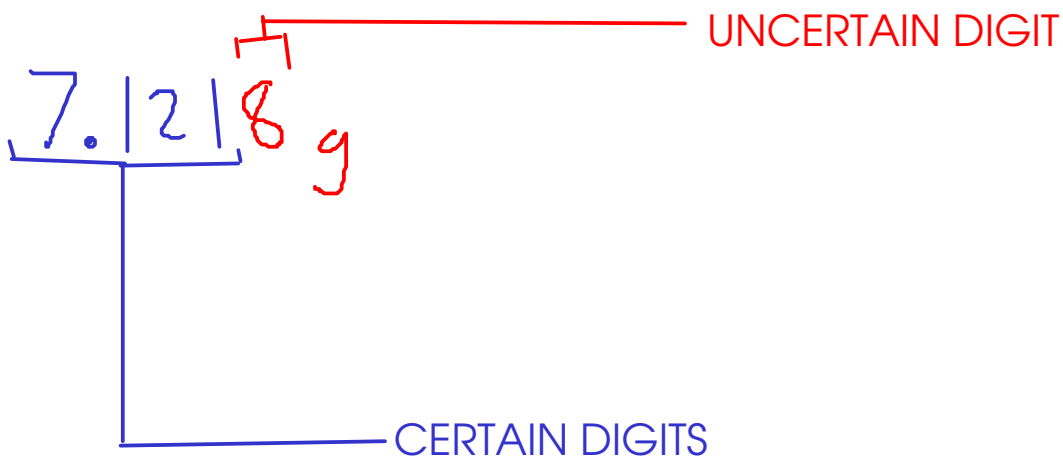
Significant figures

SIGNIFICANT FIGURES are a way to indicate the amount of uncertainty in a measurement.

The significant figures in a measurement are all of the CERTAIN DIGITS plus one and only one UNCERTAIN (or estimated) DIGIT

Example:

From our classroom experiment,



This is a FIVE SIGNIFICANT FIGURE measurement!

Determining significant figures

When you read a measurement that someone has written using the significant figures convention, you can tell how precisely that measurement was made.

1.473 g ± 0.001 g ← approximate uncertainty

This was measured to the nearest +/- 0.001 g
The last digit is always UNCERTAIN (or estimated)

21 m ± 1 m

37.26 kg ± 0.01 kg

Some other examples

3.2076 g $(\pm 0.0001$ g$)$

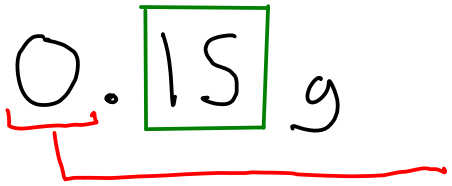
27.3 m $(\pm 0.1$ m$)$

A small problem

The number ZERO has several uses. It may be a measured number, but it may also be a mere "placeholder" that wasn't measured at all!

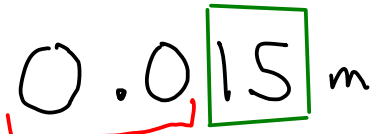
So how do we tell a measured zero from a placeholder? There are a few ways:

1: BEGINNING ZEROS: Beginning zeros are NEVER considered significant.



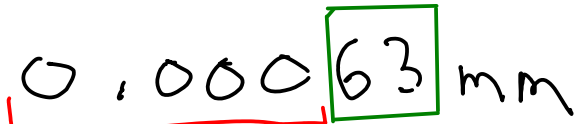
(.15 g ... another way of writing 0.15 g)

This zero merely indicates that there is a decimal point coming up!



(1.5 cm)

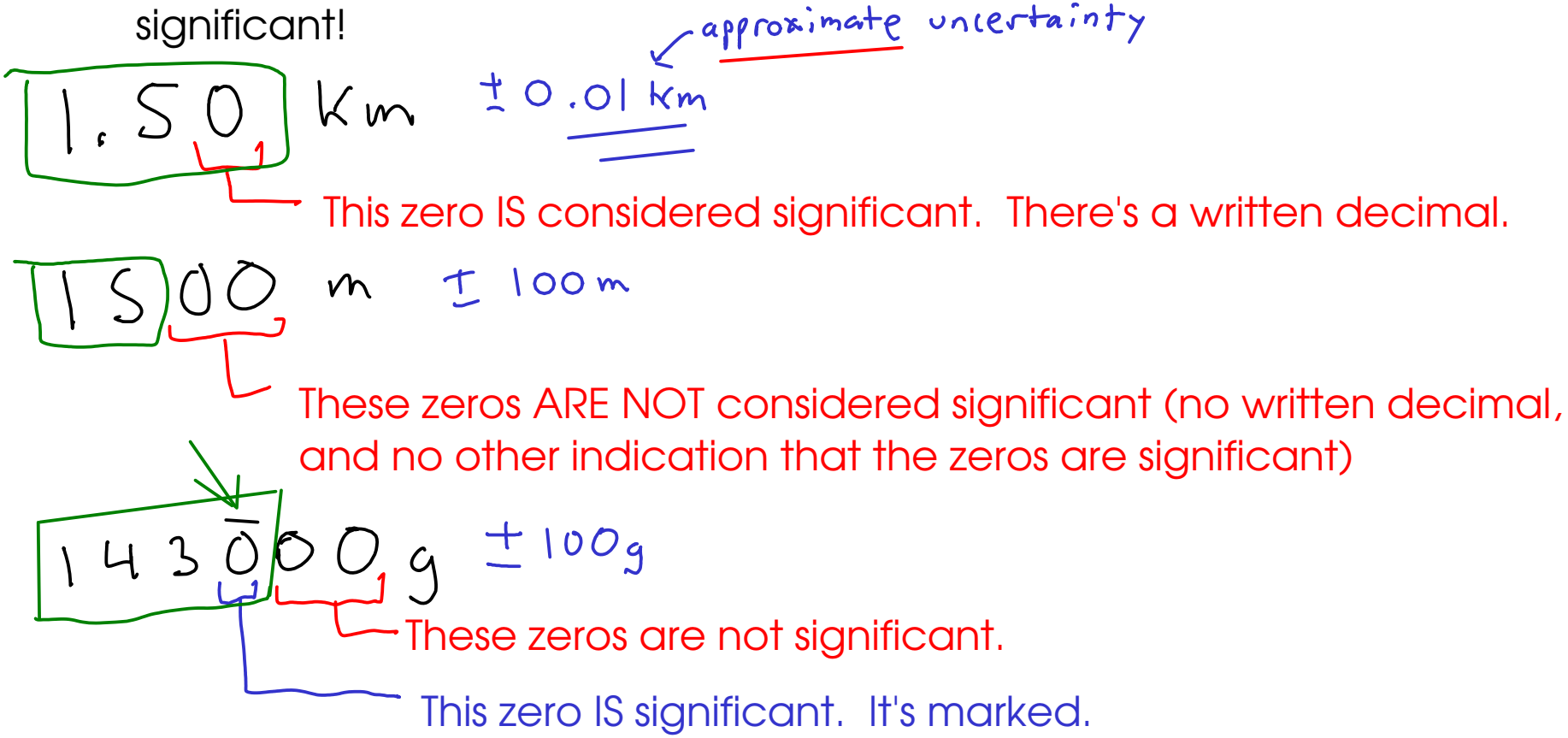
These zeros are placeholders. They'll disappear if you change the UNITS of this number!



None of these zeros are considered significant

2: END ZEROS are sometimes considered significant. They are significant if

- there is a WRITTEN decimal point in the number
- there is another written indicator that the zero is significant. Usually this is a line drawn over or under the last zero that is significant!



How many significant figures are there in each of these measurements?

76.070 g (±0.001 g)
5

85000. mm (± 1 mm)
5
decimal point

0.001030 kg (±0.000001 kg)
4

156.0002 g (± 0.0001 g)
7

0.10 s (± 0.01 s)
2

17000000 mg (± 1000000 mg)
2

120000 km (± 100 km)
4

1350 ms (± 10 ms)
3

(Number of significant figures is indicated in RED below each measurement. Significant digits are UNDERLINED.)

(Approximate uncertainty in each of these measurements is indicated in GREEN after each one.)

Calculations with measurements

When you calculate something using measured numbers., you should try to make sure the ANSWER reflects the quality of the data used to make the calculation.

An ANSWER is only as good as the POOREST measurement that went into finding that answer!

$$\begin{array}{rll} 14.206 & \pm 0.001 \\ 154.72 & \pm 0.01 \\ 1.6 & \pm 0.1 \\ + \quad 0.222 & \pm 0.001 \\ \hline 170.748 \end{array}$$

How should we report this answer? How much uncertainty is in this answer?

170.7

- If you add an uncertain number to either a certain or an uncertain number, then the result is uncertain!
- If you add certain numbers together, the result is certain!