Our classroom experiment: Results

Mass of ring (g)	
42.1264	42.1087
42.1270	42.1086
42.1189	42.1083
42.1084	42.1083
42.1547	42.1080
42.1539	42.1090
42.1069	
42.1088	
42.1090	
42.1083	
42.1090	

(17 measurements)

Overall average

$\bar{x} = 42.1166\,g$

$= 42.12\,g \; (\pm 0.01\,g)$

CERTAIN DIGITS: Appear in nearly all repeats of the measurement

UNCERTAIN DIGITS: Vary.. Variation caused by estimation or other sources of random error.

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

When using a digital device, record all the displayed digits.

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,

42.12 g

This digit was estimated by the balance (it varied between measurements). This is an UNCERTAIN digit.

These digits were obtained in nearly all measurements of the ring. They are CERTAIN.

THIS MEASUREMENT HAS FOUR SIGNIFICANT FIGURES

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

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

21 m ±1

37.26 kg ±0.01

Some other examples

3.2076 g (±0.0001 g)

27.3 m (±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.

0.15 g

.15 g

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

0.015 m (1.5 cm)

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

0.00063 mm

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!

1.50 Km ± 0.01 Km

This zero IS considered significant. There's a written decimal.

1500 m ± 100 m

These zeros ARE NOT considered significant (no written decimal, and no other indication that the zeros are significant)

1430̄00 g ± 100 g

These zeros are not significant.

This zero IS significant. It's marked.

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

76.070 g

5

85000. mm

5

decimal point

0.001030 kg

4

156.0002 g

7

0.10 s

2

17000000 mg

2

120000 km

4

1350 ms

3

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!

	14.206	±0.001
	154.72	±0.01
	1.6	±0.1
+	0.222	±0.001
	170.748	

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

$\boxed{170.7}$

* 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!