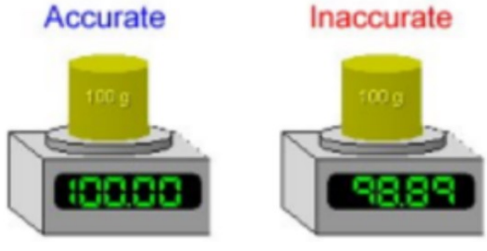
Measurement and significant figures

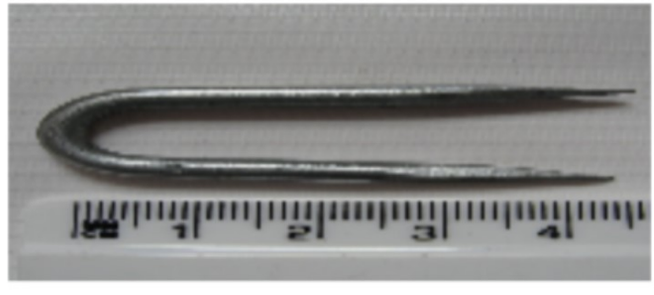
The Quality of Experimental Results

Precise but not accurate

Accurate but not precise

Accurate and precise





Which digits are significant?

- **Rule #1**: All non-zero numbers are significant.
  24 has two sig figs, 24.1 has 3 sf

- **Rule #2**: All zeros bounded by non-zero numbers are significant. (Sandwiched)
  200 004 has 6 sig figs, 200.04 has 5 sf

- **Rule #3**: Zeros placed before other digits (leading zeros) are not significant.
  0.024 has 2 sf ~~0.0000~~045 has 2 sf

- **Rule #4**: Zeros at the end of a number (trailing zero's) are significant ONLY if they come after a decimal point (and a significant digit).
  2.40 has three sf 2.400 has 4 sf
  240, 2 400 and 24 000 all have 2 sf
  ↑ Not after decimal

Practice:

409.25 5	0.050 2	0.003500 4
83 2	300 900 4	0.916 3
98.207 5	4.67×10^{-7} 3	0.200 3
0.001 1	45.030 5	5 234 000 4
4.3×10^{2} 2	35 000 2	150 000 001 9
0.003050 4	0.004400 4	460 090 5
4 200 2	16.8090 6	50.00300 7

Rules for Multiplication and Division

To determine how many sig figs your final answer should have, you must use the number with the **least** amount of sf in the question that is being multiplied or divided.

Ex 1- 15.0 (3) x 4.515 (4) x 1376 (4) = 93 189.6 (>3) --> 93 200

Ex 2- 0.003 (1) x 0.050 (2) x 0.04 (1) = 0.000006 (>1) --> 0.000006

Ex 3- 45.56 (4) x 134.04 (5) x 0.340 (3) = 2076.3332 (>3) --> 2080

Ex 4- 34.56 (4) x 14 (2) x 134.020 (6) = 64844.2368 (>2) --> 65 000

Exceptions and Rules

1. Rounding off and keeping a zero as a significant digit

$\frac{8253.0569}{12.7} = 649.847$

- In this example you must keep 3 sig figs in your answer.

When rounding off 649.847 should become 650.

Problem, 650 only has 2 sig figs
Solution: put a – above the zero, this makes it significant. -->

Or use Scientific Notation --> 6.50×10^2

2. Converting units

- When converting units, sig figs need to be maintained.

Ex 1- 4.0 cm to m becomes 0.040 m
Ex 2- 1250 mL to L becomes 1.25 L

3. Constants (a fixed number)

- When there is a constant in a formula, the constant does not count as a significant figure.

ex: Coulomb's constant $9 \times 10^9\ Nm^2/C^2$
ex: Earth's Gravitational Constant $9.807\ m/s^2$

ex: π (pi)
3.14159265358979323846264338327950288419 7

^Technically, it has 39 sig figs because it has 39 digits
However, it is a constant, so we do not consider its number of sig figs in an equation

Ex: Find the circumference of a circle with a radius of 2.0 m. 2 SF

$C = 2\pi r$
$C = 2\pi(2.0)$
$C = 12.56637\ m$ (we only want 2 sf)

C = 13 m (2 SF)

(we ignored the '2' and the 'π'. We only considered the '2.0' for sf)

SIG FIGS

1. How many sig figs are in each of the following numbers?

a) 0.09304 4
b) 6.58×10^{7} 3
c) 0.0200 3
d) 0.10101 5
e) 4.508 4
f) 1204.0 5
g) 2.9×10^{-3} 2
h) 2.4×10^{7} 2
I) 460 2
J) 23.230 5

2. Solve using the correct number of significant figures.

a- $13.5 \times 14.2 \times 13.080 \times 0.01 =$ (3, 3, 5, 1)

25.07436 --> 30

b- $187 \times 0.008 \div 14.2887 =$ (3, 1, 6)

0.104698118 --> 0.1

c- $911 \times 677 \times 0.0089 =$ (3, 3, 2)

5489.0483 --> 5500

d- $8.0 \times 10^{5} \div 4.02 \times 10^{9} =$ (2, 3)

0.000199005 --> 0.00020

e- $(1.23 \times 10^{5})\ (1.445 \times 10^{7}) \div 0.023 =$ (3, 4, 2)

$7.727608696 \times 10^{13}$ --> $7.7 \cdot 10^{13}$