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

76.070 g ± .001 g

5

85000. mm ± 1 mm

5

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!

$$\begin{array}{r} 14.206 \\ 154.72 \\ 1.6 \\ +\ 0.222 \\ \hline 170.748 \end{array}$$

Round so that there's only one uncertain digit in the answer!

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

170.7 ± 0.1

- 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!

For addition and subtraction, round FINAL ANSWERS to the same number of decimal places as the measurement with the fewest decimal places. This will give an answer that indicates the proper amount of uncertainty.

For multiplication and division, round FINAL ANSWERS to the same number of SIGNIFICANT FIGURES as the measurement with the fewest SIGNIFICANT FIGURES!

4 3 3

$15.62 \times 0.0667 \times 35.0 = 36.46489$

How should we report this answer?

36.5

3 2 5

$25.4 \times 0.00023 \times 15.201 = 0.088804242$

How should we report this answer?

0.089

A few more math with significant figures examples:

$$\underset{5}{15047} \times \underset{2}{11} \times \underset{4}{0.9876} = 163464.5892$$

160000

~~160000~~

Placeholder zeros, even though they aren't SIGNIFICANT, still need to be included, so we know how big the number is!

147.3
2432
0.97
+ 111.6
2691.87

2692

DENSITY CALCULATION

$$\frac{14.7068\ g}{2.7\ mL} = 5.446962963\ g/mL$$

(6 significant figures; 2 significant figures)

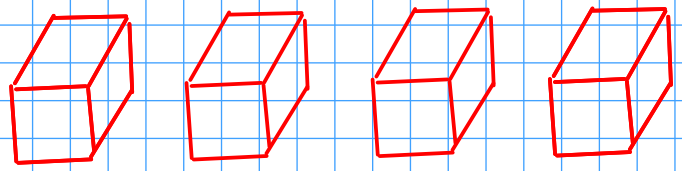
5.4 g/mL

To improve (make more precise) this calculated density, we must improve the poorest measurement. We must use a more precise device to measure the VOLUME (which only has two significant figures in this example)!

Exact Numbers

- Some numbers do not have any uncertainty. In other words, they weren't measured!

1) Numbers that were determined by COUNTING!



How many blocks are to the left?

exactly 4!

2) Numbers that arise from DEFINITIONS, often involving relationships between units

$12\ in = 1\ ft$

$Km = 10^3\ m$

*All metric prefixes are exact!

- Treat exact numbers as if they have INFINITE significant figures!

Example

You'll need to round the answer to the right number of significant figures!

Convert 4.45 m to in, assuming that 2.54 cm = 1 in*

$1\ cm = 10^{-2}\ m \qquad 2.54\ cm = 1\ in$

$$4.45\ m \times \frac{cm}{10^{-2}\ m} \times \frac{1\ in}{2.54\ cm} = 175.196850\ in$$

3 sf ; ∞ sf ; ∞ sf

$$= \boxed{175\ in}$$

*An inch is defined as EXACTLY 2.54 cm !