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!

$\boxed{1.50}$ Km ± 0.01

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

$\boxed{15}00$ m $\pm$ 100 m

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

$\boxed{143\bar{0}}00$ g $\pm$ 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 ± 100 km

4

1350 ms ± 10 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!

$$
\begin{array}{r}
14.20\underline{6} \\
154.7\underline{2} \\
1.\underline{6} \\
+\quad 0.22\underline{2} \\
\hline
170.\underline{748}
\end{array}
$$

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?

$\boxed{170.7}$ $\pm 0.\underline{1}$

* 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!

$$\overset{4}{\underline{15.62}} \times 0.0\overset{3}{\underline{667}} \times \overset{3}{\underline{35.0}} = 36.46489$$

How should we report this answer?

$$\boxed{36.5}$$

$$\overset{3}{\underline{25.4}} \times 0.000\overset{2}{\underline{23}} \times \overset{5}{\underline{15.201}} = 0.088804242$$

How should we report this answer?

$$\boxed{0.089}$$

A few more math with significant figures examples:

$\overset{5}{15047} \times \overset{2}{11} \times \overset{4}{0.9876} = 16|3464.5892$ $\boxed{160000}$ ~~16~~

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

1.6×10^5 also ok

Addition:

$$
\begin{array}{r}
147.3 \\
2432 \\
0.97 \\
+\ 111.6 \\
\hline
2691.87
\end{array}
$$

$\boxed{2692}$ ± 1

DENSITY CALCULATION

$$\frac{\overset{6}{14.7068}\ g}{\underset{2}{2.7}\ mL} = 5.4|4696296\,3\ g/mL$$

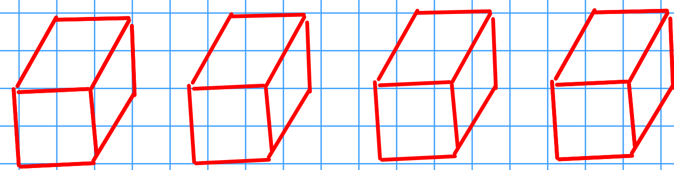
$\boxed{5.4\ g/mL}$

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 $\underline{\underline{4}}$

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

$12 \text{ in} = 1 \text{ ft}$

$\text{Km} = 10^3 \text{ m}$

* 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 $\underbrace{\text{2.54 cm = 1 in}}_{\text{EXACT!}}$

$$2.54\ cm = 1\ in$$

$$cm = 10^{-2}\ m$$

$$\underbrace{4.45\ \cancel{m}}_{3} \times \underbrace{\frac{\cancel{cm}}{10^{-2}\ \cancel{m}}}_{\infty} \times \underbrace{\frac{1\ in}{2.54\ \cancel{cm}}}_{\infty} = 175.196850394\ in$$

$$\boxed{175\ in}$$

DALTON'S ATOMIC THEORY

- 1808: Publication of Dalton's "A New System of Chemical Philosophy", which contained the atomic theory

- Dalton's theory attempted to explain two things:

1. CONSERVATION OF MASS
   - The total amount of mass remains constant in any process, chemical or physical!

2. LAW OF DEFINITE PROPORTIONS (also called the LAW OF CONSTANT COMPOSITION): All pure samples of a given compound contain the same proportion of elements by mass