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

$120\bar{0}00$ 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!

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!

$\underset{4}{15.62} \times \underset{3}{0.0667} \times \underset{3}{35.0} = 36.46489$

How should we report this answer?

$\boxed{36.5}$

$\underset{3}{25.4} \times \underset{2}{0.00023} \times \underset{5}{15.201} = 0.088804242$

The first significant figure is the leftmost "8" because lead zeros are not considered significant.

How should we report this answer?

$\boxed{0.089}$

A few more math with significant figures examples:

5 2 4

$15047 \times 11 \times 0.9876 = 163464.5892$ $\boxed{160000}$ 1.6×10^{5}

~~16~~

Placeholder zeroes (or scientific notation) required here since we need to know where the decimal goes!

Addition:

147.3	± 0.1
2432	± 1
0.97	± 0.01
+ 111.6	± 0.1
2691.87	

$\boxed{2692}$

DENSITY CALCULATION

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

6, 2

$\boxed{5.4 \text{ g/mL}}$

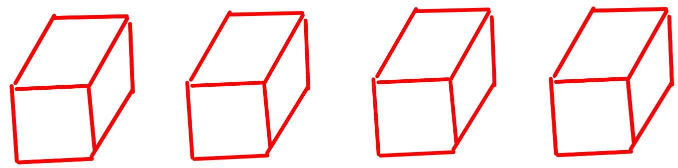
The only way to improve the precision of this density measurement is to improve the precision of the VOLUME measurement, since it limits the precision of the answer.

(We can actually use a LESS precise balance than the one we're currently using and still have the same quality density measurement!)

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

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

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

* All metric prefixes are exact!

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

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

EXACT!

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

$$4.45\ \cancel{\text{m}} \times \frac{\cancel{\text{cm}}}{10^{-2}\ \cancel{\text{m}}} \times \frac{\text{in}}{2.54\ \cancel{\text{cm}}} = 175.1968504\ \text{in}$$

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

3 $\quad \infty \quad \infty$

Usually, in unit conversions the answer will have the same number of significant figures as the original measurement did.

EXCEPTION: Temperature conversions, since these often involve ADDTION (different rule!)

A note on rounding: If possible, try to round only at the END of a multiple-step calculations. Avoid rounding intermediate numbers if possible, since extra rounding introduces ERROR into your calculations.

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