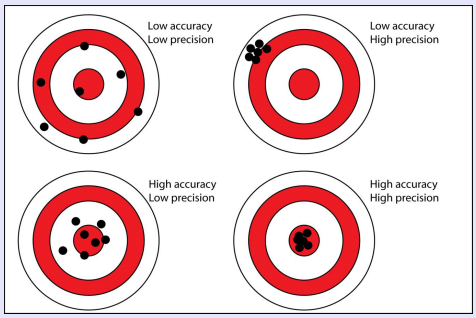
# The Measure of Science

There are many mathematical calculations performed when measuring physical properties and scientists around the world use a set of rules to indicate the degree of accuracy and precision of these measurements. All measurements are subject to uncertainty.

**Precision** - is the degree of exactness to which a measurement can be reproduced.

**Accuracy** - describes how well the result agrees with an accepted value.

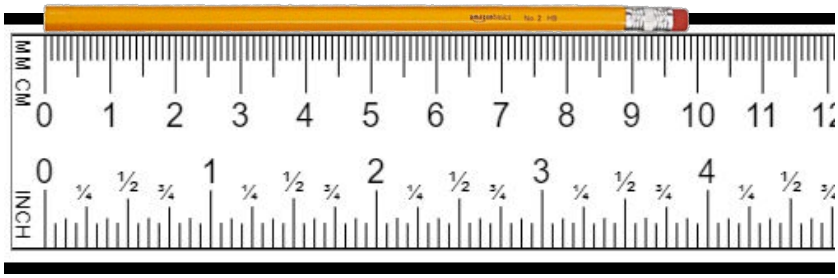



https://www.vox.com/science-and-health/2018/11/14/18072368/kilogram-kibble-redefine-weight-science

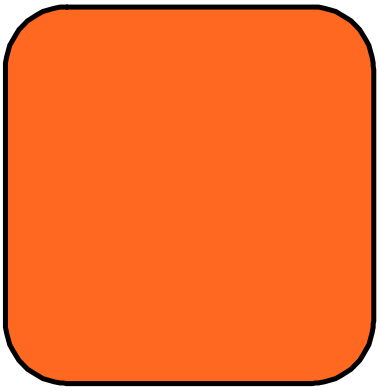
What are significant figures??

- the number of digits in a measurement we know **<u>for certain</u>** *plus one additional uncertain digit.*

For example...




What would you report the length of the object to be??



If it were zoomed in, does that change your answer?

What other measuring devices can you think of where significant figures would apply? What about some that won't?

Significant figures have specific rules that we follow:

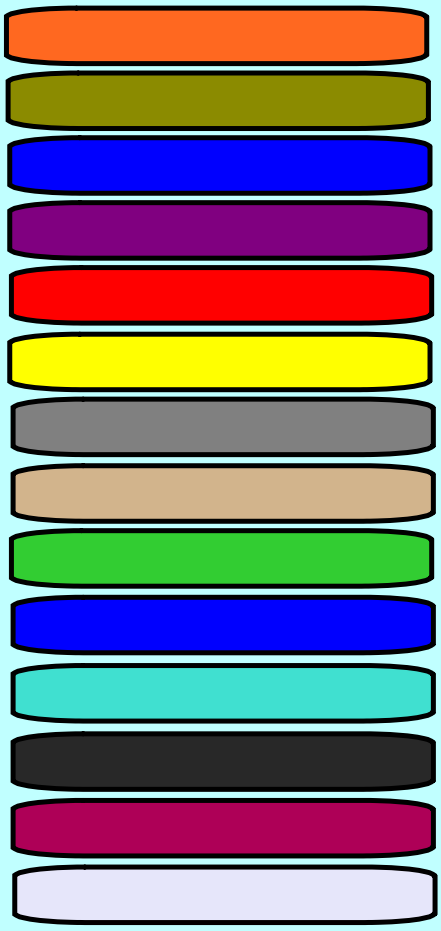
- include all non-zero digits. (2.59 - three sig fig)
- include any zeros between two non-zero digits (507 - three sig fig)
- include any zeros to the right of <u>both</u> the decimal point and a non-zero digit. (4.60 - three sig fig) or (700.0 - four sig fig)
- include all digits (zero or non-zero) used in scientific notation

**<u>Digits that are NOT significant include</u>**....

- any zeros to the right of a decimal point but preceding a non-zero digit. (0.000045 g - two sig dig)
- any zeros to the right of a non-zero digit. (38 000 - two sig dig)

Lets try a few... guess how many significant figures each number has.

425.6 m
1.05 km
9.6093 kg
5.0 g
6 lbs
0.5 hr
600 g
600.0 g
0.24 m
0.006
0.0245
0.42
0.00560
$173.2 \times 10^{-3}$ M



## Need some extra practice? Try these!

$3.0 \times 10^{8}$ m/s (speed of light) 0.7 s 9.7 ounces

15 000 000 L 6.7523 km 3.45 m

0.0000410 kg $9.109 \times 10^{-31}$ kg (mass of an electron)

0.08905 L 4.501 hm 440 µm 4.0 cm

$6.02 \times 10^{23}$ amu (Avogadro's number) 0.00465 km 0.454g

Try it here: https://quizlet.com/_673j0h

## Rounding

- if the number after the digit to be kept as significant is a 5 or greater, - round UP.
- if the nuber after the digit to be retained as significant is a 4 or less, - round DOWN. (leave digit as is)

*Important* - Never round a value too early when more calculations need to be done. It will give you an incorrect answer.

## Adding and Subtracting Significant Figures

- when adding and subtracting significant figures, the answer (sum or difference) has the same number of place values as the measured value with fewest place value.

i.e.)

12.45 cm + 4.2 cm = 16.65 cm

report answer as: = 

3.26 km + 5.4698 km = 8.7298 km

report answer as: = 

7.8521 L + 0.032 L = 7.8841 L

report answer as: = 

## Multiplying and Dividing Significant Figures

- when multiplying and/or dividing significant figures, the answer has the same number of significant figures as the measurement with the fewest number of significant figures.

i.e)

6.71 m × 7.850 m = 52.6735 $m^2$

report answer as: =

2.4 cm × 0.08 cm = 0.192 $cm^2$

report answer as: =

0.4251 L × 39.7525 L = 16.89878785 $L^2$

report answer as: =

44.794 g ÷ 19.13 cm = 2.341557762676.... g/cm

report answer as: =

## Calculating Significant Figures with Multi-Step Problems

Use order of operations and keep track of your significant figures throughout the problem.

Example: Solve with the proper number of significant figures.

$$\frac{1.07 - 0.8826}{0.762}$$

$$\frac{82.7}{0.18} + 114.25$$

## Rearranging Formulas

Hints to rearrange formulas:

1. Eliminate any fractions
2. Add/subtract any terms to the other side of the equals sign that do not contain the variable
3. Divide by any coefficients in front of the variable
4. Take the root of any power on the variable

## Examples

Solve the following equation for $x$

$$\frac{ay}{x} = \frac{cb}{s}$$

Solve the following equation for $x$

$$y = mx + b$$

$$v_f^2 = v_i^2 + 2ad \qquad \text{for } v_i$$

# Measure of Science Worksheet