

# Measurement and Number

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## Measurement: the basis of all Science

- Science is based on measurement
- Measurements are comprised of two parts: a number indicating how much and a unit indicating of what

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The moon is 395,000 away.  
This makes no sense. We need to know how many of what.

The moon is km away.  
This also makes no sense for the same reason.

The moon is 395,000 km away.  
This is the only way it makes sense.

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## Units: the descriptors of measurements

- Unit systems
  - English
  - Metric

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## Differences between unit systems

<u>Metric system</u>	<u>English System</u>
<ul style="list-style-type: none"><li>• Based on powers of ten</li><li>• Usually based on physical phenomena</li><li>• A few base units with prefixes</li></ul>	<ul style="list-style-type: none"><li>• No common base for all units</li><li>• Based on arcane references</li><li>• A proliferation of various units</li></ul>

Science, almost exclusively, uses the metric (SI) system.

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## Differences between Metric and SI systems

<u>Metric system</u>	<u>SI</u>
<ul style="list-style-type: none"><li>• Mass unit is the gram</li><li>• Temperature unit is °C</li></ul>	<ul style="list-style-type: none"><li>• Mass unit is the kg</li><li>• Temperature unit is K</li></ul>

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## Base units in the metric system.

- For mass is the gram (g)
- For length is the meter (m)
- For time is the second (s)
- For temperature is the degree Celsius (°C)
- For amount is the mole (mol)

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## Prefixes in the metric system

Prefixes indicate a multiplier to be used to have the correct size of the unit

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Need to Memorize!!!

Prefix	Multiplier
Pico (p)	$10^{-12}$
Nano (n)	$10^{-9}$
Micro ( $\mu$ )	$10^{-6}$
Milli (m)	$10^{-3}$
Centi (c)	$10^{-2}$
Kilo (k)	$10^3$
Mega (M)	$10^6$
Giga (G)	$10^9$

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## Numbers in measurements

- Numbers are essential to a measurement
- They tell us how many.
- They indicate the precision of the measurement

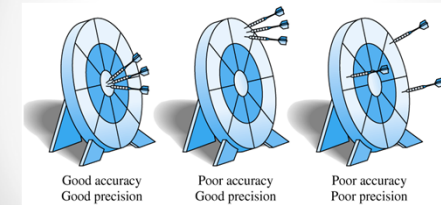
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## Precision and Accuracy

- Precision is a measure of how close measurements are to each other.
- Accuracy is a measure of how close measurements are to the accepted value.
- Precision and accuracy are not the same thing.

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## Precision and Accuracy



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## Scientific Notation

- Also convenient for converting number that have an ambiguous number of sig figs to an unambiguous number.

44,000 km is ambiguous but  $4.40 \times 10^4$  km is not (it has 3 sig figs).

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## Calculations with sig figs

- Addition and Subtraction
  - The answer cannot be more precise than the numbers you start with.
  - It should have the same number of decimal places as the smallest number of decimal places in the original numbers.

34.56

+3.7

38.26 calculator answer

38.3 rounded answer

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## More examples

	Position of uncertainty
347	← Ones position
+ 2.03	← Hundredths position
+ 23.6	← Tenths position
<hr/> 372.63	(calculator answer)
373	(correct answer)

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## Calculations with sig figs

- Multiplication and Division
  - The number of sig figs in the answer is determined by the least number of sig figs in the original numbers.

$$6.038 \times 2.57 = 15.51766 \quad (\text{calculator answer})$$

$$= 15.5 \quad (\text{correct answer})$$

This number limits the answer to three significant figures.

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