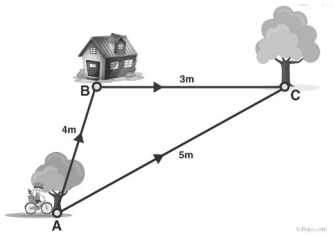
Introduction to Measurements

Measurement

A method to get **quantitative** (*number based*) information about a physical or chemical system in nature



The meter (*m*) or the yard (*yd*) can be used to measure the distance between points A and B (*park to house*), B to C (*house to tree*), or A to C (*park to tree*)

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Introduction to Measurements

Two Types of Data Analysis

Quantitative Measurements

Measurements where data is collected using a measuring tool to compare to other measurements of the same type

Qualitative Measurements

Measurements where no data is collected but comparisons are made using the main human senses (*sight, smell, touch, sound, taste*)

Examples

Weight (*mass*)
Size (*volume*)
Temperature (*heat*)
Length

Comparing reaction speed or color made
Smell, texture (*touch*), Sound

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Introduction to Measurements

Types of Quantitative Measurements

Mass
How heavy matter is (*weight*)

Volume
How many space matter takes up

Length
How long a side of matter is

Time
The duration of a measurement

Temperature
How fast (*speed*) matter is moving

Heat
How much energy matter has

Pressure
How many collisions per time

Color
The distance between light waves

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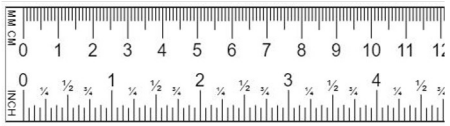
Introduction to Measurements

The *unit* of quantitative measurements

Unit (*of measure*)

The basic division we can break a measurement down into for comparison to other measurements of the same type.



Length Measurements
The ruler is broken down into inch (*imperial, bottom*) or centimeter/millimeter (*metric, top*) segments

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Introduction to Measurements

Parts of a Measurement

Quantity
The actual number of the measurement

Unit
The system of measurement used by a measurements (*ex: length = meter, m*)

Label
The description of the measurement

Examples

1.30 cups water
Quantity: 1.30
Unit: cups (*volume*)
Label: water

235.3mm stick
Quantity: 235.3
Unit: millimeter (*length*)
Label: stick

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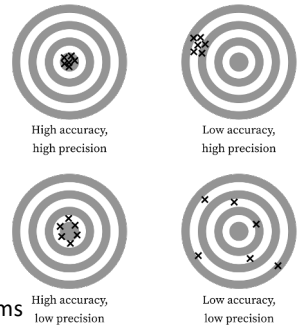
Accuracy and Precision in Measurements

Accuracy
How close a measurement is taken relative to the correct true value

Precision
How close a series of measurements taken together are to each other

Measurement sets can be accurate and/or precise. A and P are not linked to each other directly, but independent terms



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Accuracy and Precision Relationship

Known Correct (*accurate*) Measurement: 12.0 ± 0.5g CO_2(*g*)
Precise Measurement defined as $\pm$ 0.3g or better

Good Accuracy Good Precision	Good Accuracy Poor Precision	Poor Accuracy Good Precision	Poor Accuracy Poor Precision
12.0g	11.7g	16.4g	5.6g
12.1g	12.4g	16.5g	18.4g
12.0g	11.5g	16.3g	8.4g
12.1g	11.8g	16.4g	12.9g
11.9g	12.5g	16.5g	10.4g
±0.1g, 11.9 – 12.1	±0.5g, 11.5 – 12.5	±0.1g, 16.3 – 16.5	±12.8g, 5.6 – 18.4

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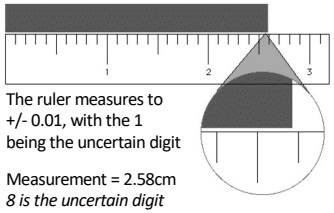
Accuracy and Precision in Measurements

Accuracy in Written Measurements
Any measurement can have any number of true, and one estimated digits in its quantity. The estimated digits is the *uncertain digit*)

In any measurement one uncertain digit always exists*

The uncertain digit is always one digit smaller than the *resolution*, the smallest marking on the scale or measuring device



The ruler measures to +/- 0.01, with the 1 being the uncertain digit

Measurement = 2.58cm
8 is the uncertain digit

* Numbers know exactly (*counts / conversion factors*) have no uncertain digits

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