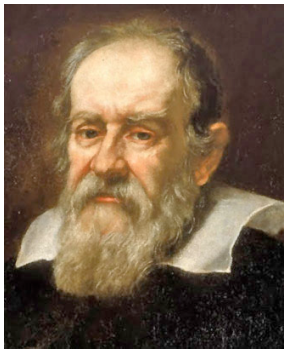
The scientific method (G. Galilei, 1564-1642)



- experimental observation of a phenomenon

  - Analyse nature, i.e. perform reproducible experiments that yield quantitative and objective data.
  - Identification of the main factors that determine the phenomenon
  - formulation of hypothesis on the nature of the phnomenon

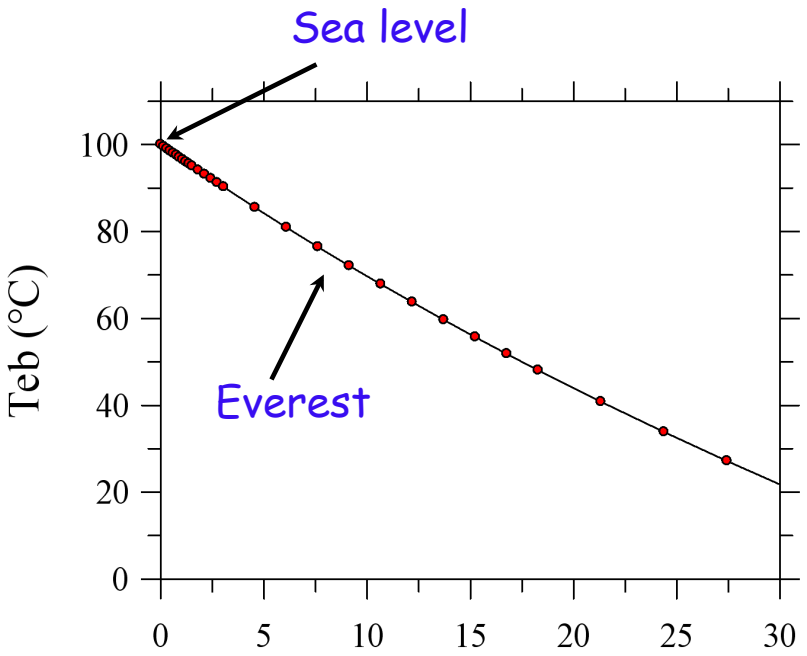
- construction of a theory

  - Allows to understand the phenomenon
  - Allows to formulate predictions on the phenomenon

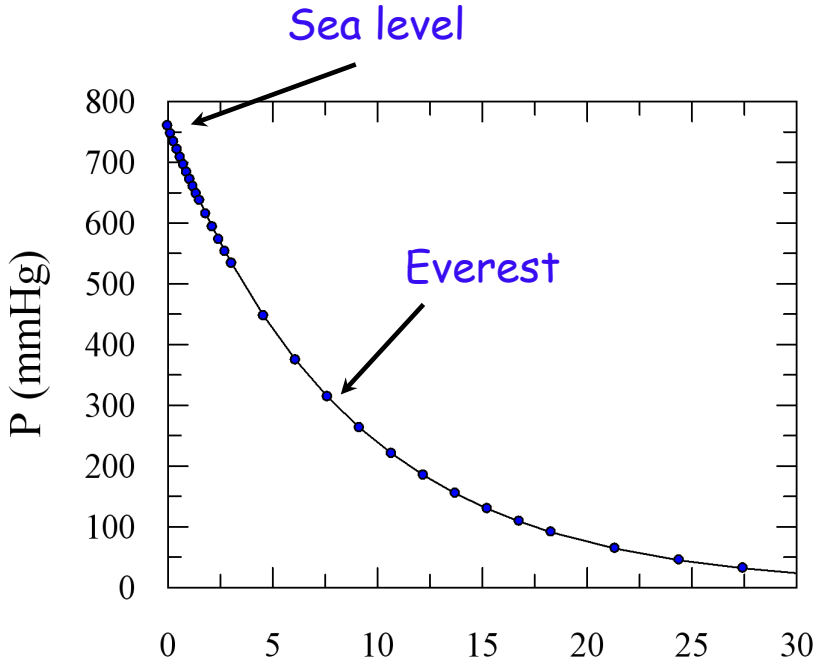
- experimental validation of the theory

  - Confirms or disproves the theoretical predictions

The boiling point of water decreases as altitude increases



Air pressure decreases as it altitude increases



Altitude (Km)

Physical quantity

- A physical quantity is any characteristic of an object or a phenomenon that can be measured, expressed through a number and unit of measure.

- The definition of a physical quantity is said to be operational since it involves precise guidelines on how it should be the measured and unit of measurement. To measure means to compare a physical quantity with a unit of measurement.

- There are some physical quantities (called base quantities) for which it is necessary to define the units of measurement in an arbitrary manner.

  meter = length of the path taken by light in vacuum during a time interval of 1 / 299792458 / 2 (ca. 3 ns)

  kilogram = mass of the international prototype kilogram

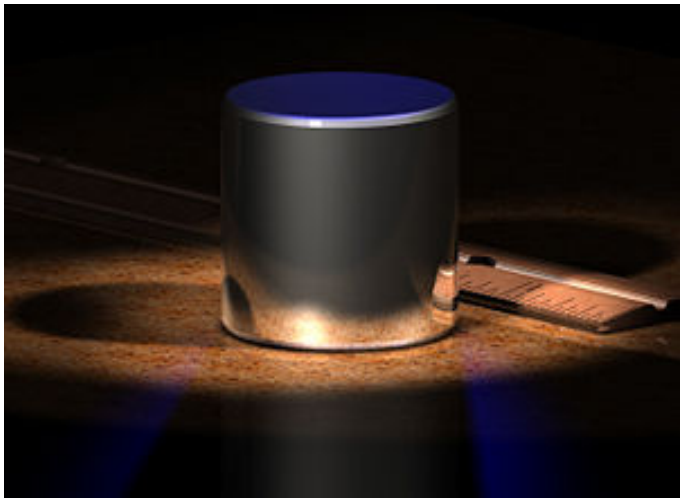
  second = time equal to 9,192,631,770 oscillations of the radiation emitted in a particular transition of the isotope of cesium 133

- The other variables, whose units are derived from those of base quantities, are called derived quantities (eg speed, area, force, etc.)

Length

The bar of platinum-iridium used as reference for the meter from 1889 to 1960

Mass



The international prototype of the kilogram (Le Grand Kilo), a cylinder that measures 39 mm in height and diameter, made from an alloy of platinum and iridium.

Time

Any phenomenon that cycles regularly can provide a unit of measurement of the duration of a certain event

International System of Units (SI)

In 1960 the General Conference on Weights and Measures introduced the International System of Units (SI).

Quantity name	Unit name	simbolo
length	*meter*	*m*
mass	*kilogram*	*kg*
time	*second*	*s*
Electric current	*Ampere*	*A*
temperature	*Kelvin*	*K*
Luminous intensity	*candela*	*cd*
Amount of substance	*mole*	*mol*

Scientific notation

- ✓ is a way of writing numbers that allows values too large or small to be conveniently written in standard decimal notation

$$x = a \times 10^{b}$$

- ✓ ***a*** *is any real number 1≤ a <10, and* ***b*** *is an integer (positive or negative)*

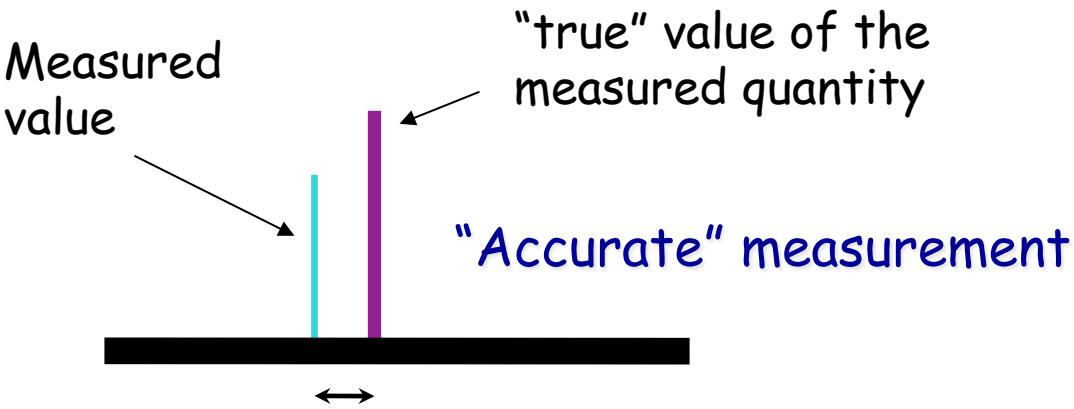
- ✓ The number is written by placing a comma after the first digit different from zero, multiplied by an appropriate power of 10, positive or negative.

Examples:

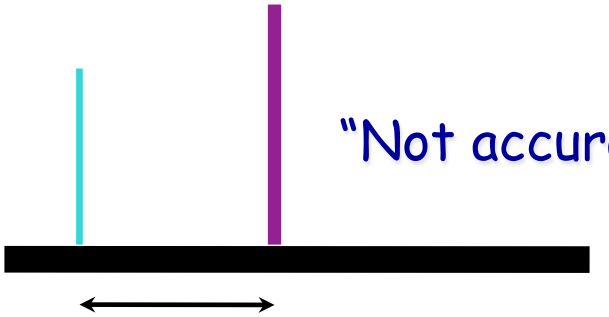
- ➢ 456,7 kg → $4{,}567 \cdot 10^{2}$ kg
- ➢ 0,00345 kg → $3{,}45 \cdot 10^{-3}$ kg

PREFIX	***VALUE***	***SYMBOL***	***PREFIX***	***VALUE***	***SYMBOL***
DEKA	*10*	*da*	*DECI*	10^{-1}	*d*
HECTO	10^{2}	*h*	*CENTI*	10^{-2}	*c*
KILO	10^{3}	*k*	*MILLI*	10^{-3}	*m*
MEGA	10^{6}	*M*	*MICRO*	10^{-6}	μ
GIGA	10^{9}	*G*	*NANO*	10^{-9}	*n*
TERA	10^{12}	*T*	*PICO*	10^{-12}	*p*
PETA	10^{15}	*P*	*FEMTO*	10^{-15}	*f*

The accuracy of the measurement of a physical quantity indicates if the measured value approaches the "true" value of the quantity examined.
Higher accuracy = closer to the "true" value.



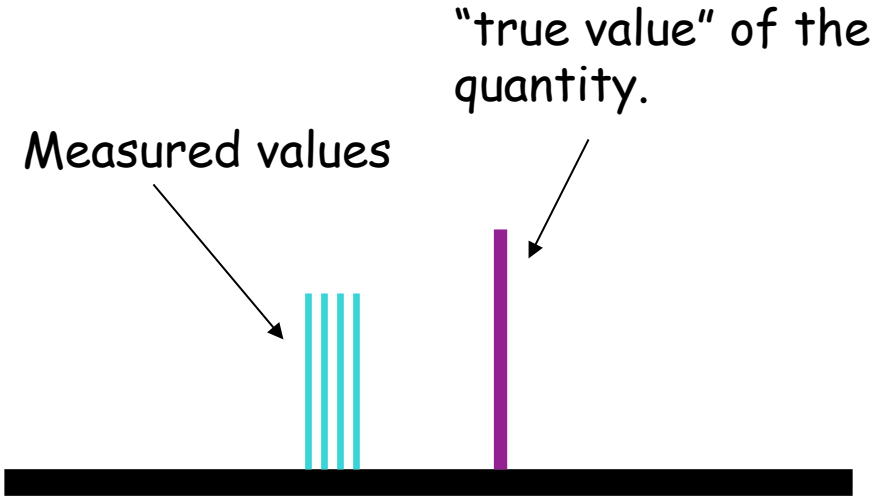
"Accurate" measurement



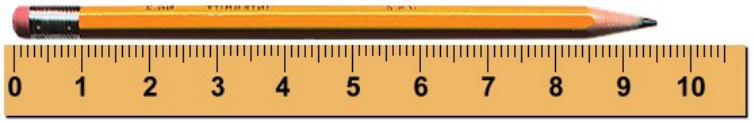
"Not accurate" measurement

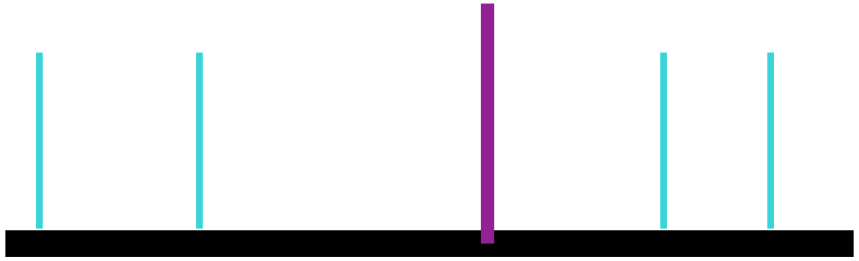
The precision of a measurement indicates how several measurements of the same physical quantity are in agreement with each other.

Higher accuracy = smaller difference between multiple measurement.

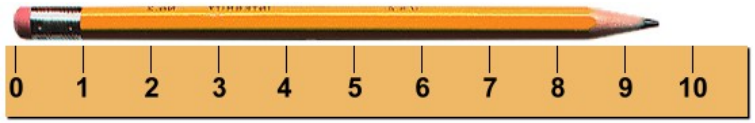


Precise measurement





Imprecise measurement



Precision and accuracy

Low accuracy and high precision

Accuracy and low precision

Accurate and precision

An accurate measurement can be precise and a precise one can be inaccurate.