

Measurement

- the assignment of numbers to objects or events
- a type of **quantitative observation** made with a **measuring instrument**
- includes both a **number** and a **unit**
- **units** of measurement are essentially **arbitrary**: people make them up and then agree to use them

Measuring is an important part of everyday life!

What can we measure?

Why do we measure?

How can we measure?

How well can we measure?

WHAT can we measure?

- Length
- Distance on land
- Depth of water
 - Mass
 - Time
- Temperature
- Electric current
 - Light
 - Color

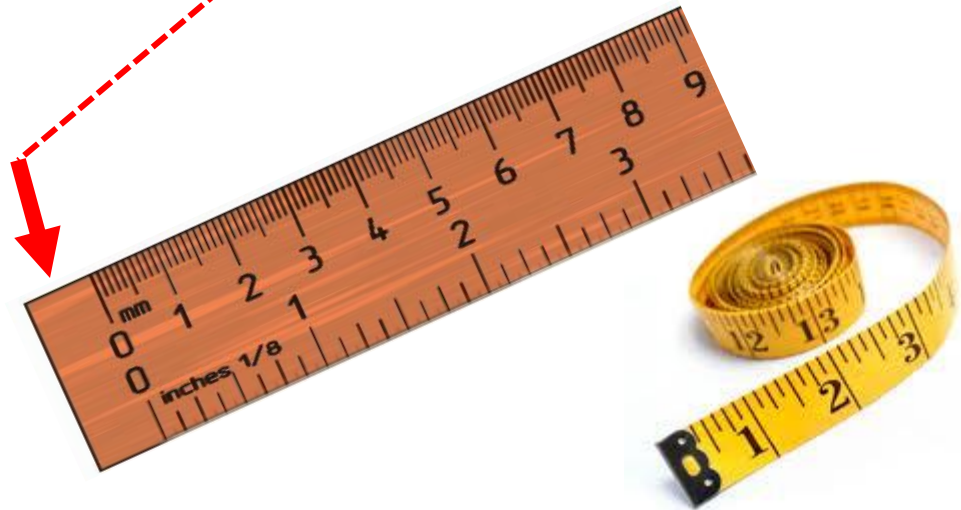
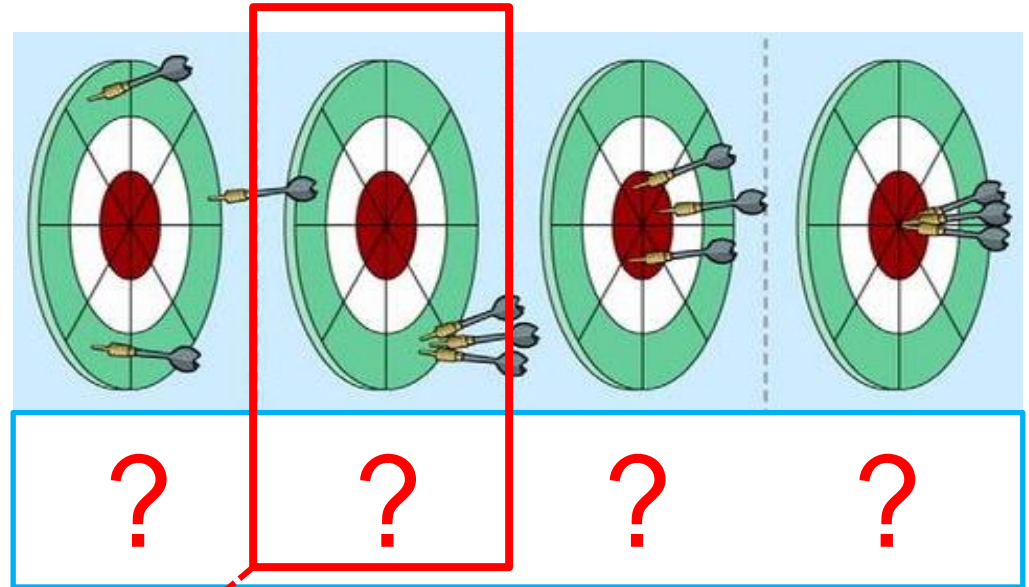
And HOW?

- ✓ Ruler
- ✓ Measuring Chain/Tape
- ✓ Rod/Cable/Sonar
- ✓ Weighing scale
- ✓ Clock, timer
- ✓ Thermometer
- ✓ Ammeter
- ✓ Photometer
- ✓ Spectrometer

**AND
SO
ON...**

How good is the measurement?

- **Accuracy** is how close a measured value is to the *actual (true) value*.
- **Precision** is how close the measured values are to *each other* (repeatability and reproducibility).
- **Bias** is a built-in (systematic) error which makes *all measurements wrong by a certain amount*.



Early Measurement Units

were based on **body parts** or **common objects**

- People have *different sized body parts*, as well as there is a *variety among common objects* like grains...



Barleycorn



Wheat



Grain, India

- ...so measurements are *not accurate*, especially when dealing with *fractions* and *multiples*...

SOLUTION: Standard Measurement Systems!

What is a System of Measurement?

A system of measurement is a collection of units of measurement and rules relating them to each other.

- Must have **base units** defined for all major quantities that need to be measured (example: a *foot*).
- Must specify **equivalency** relationship for all **additional units** used to measure the same quantity (example: length can also be measured in *inches* or *miles*, defined as 1 foot = 12 inches, 1 mile = 5280 feet).

Systems of measurement have historically been **important, regulated** and **defined** for the purposes of science and commerce.

English Units Based Systems

- **Imperial System of Measurement (British Empire, 1824):**
 - Distance/Length: Inch, foot, yard, mile
 - Volume: fluid ounce, pint, quart, gallon
 - Area: Acre
 - Weight/Mass (three different systems!): grain, ounce, pound, stone, ton



- **US Customary System of Measurement:**
 - Mostly *same unit names*
 - **Units are not identical!**
(1 US gal=0.83 imp gal)
 - Different units for liquid and dry measures (liquid/dry ounce)

