Describe the Elephant

Observation should NOT include opinion!

It weighs 480 kilograms.

It has large ears and long trunk.

It has gray wrinkly skin.

~~It is very cute!~~

It is young.

It is about 1.5 yards tall.

Qualitative vs Quantitative Data

QuaLitative (letters)

- **Descriptions** using **words**.
- Data which can be **observed** but **not measured**.
- What the object is *like*: texture, smell, taste, appearance, etc.

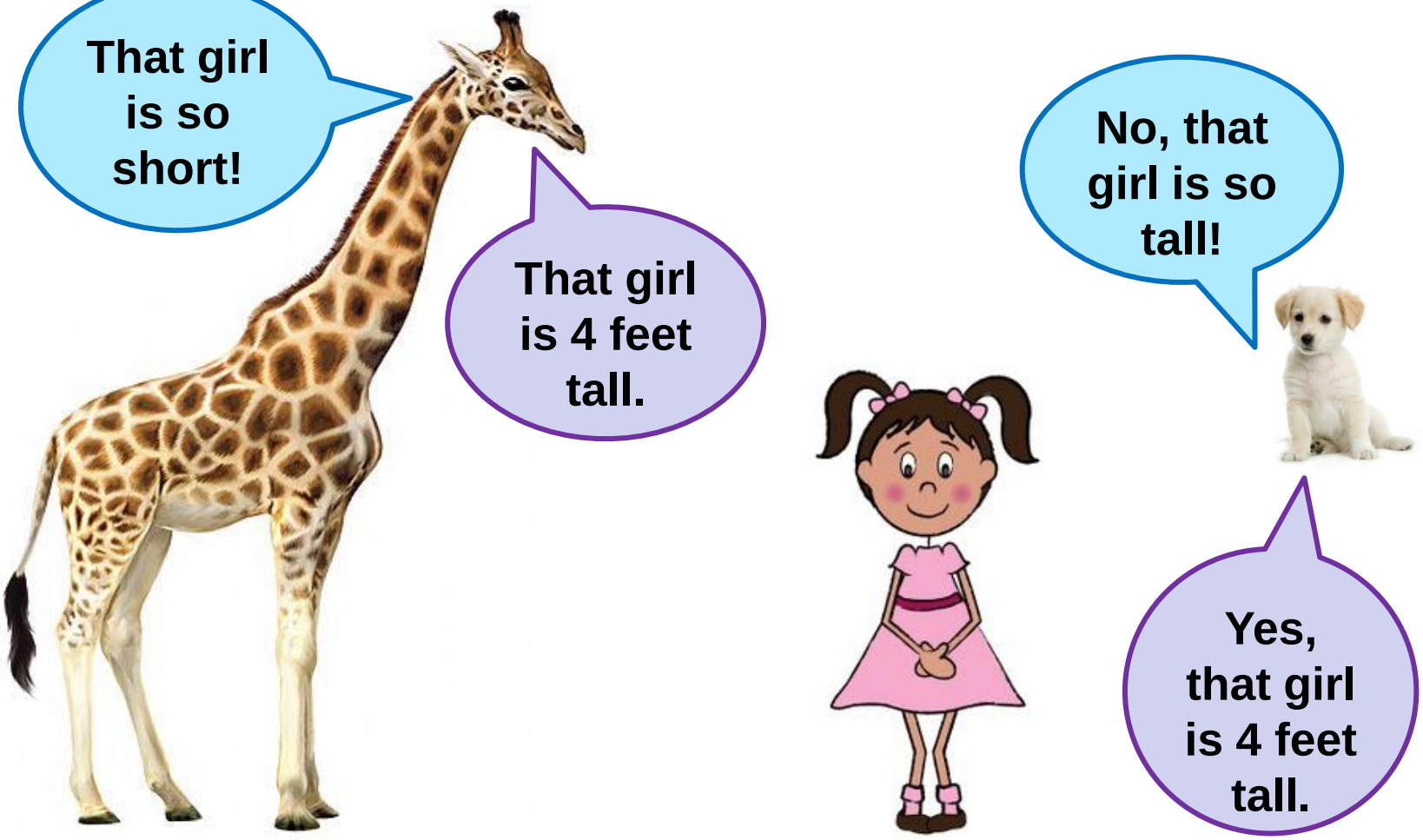
Subjective, relative

QuaNtitative (numbers)

- Specific **numbers**.
- Data which can be **measured**.
- Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, age, etc.

Objective, specific

Qualitative observations are subjective



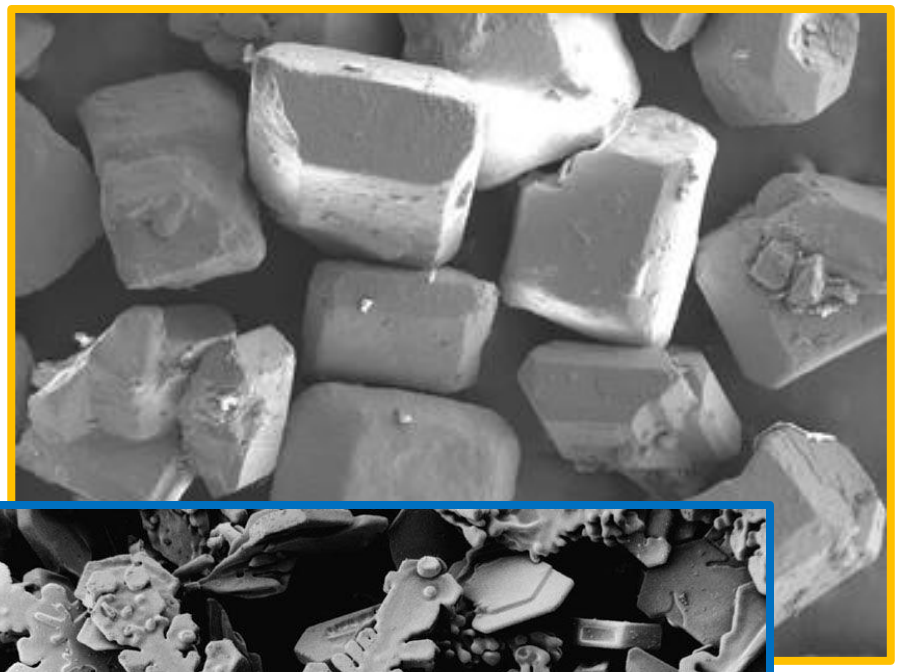
Quantitative observations are objective

DIY: Octopus Minor

Make at least **one qualitative observation** and at least **two quantitative observations** about the specimen in the picture above.

Describe the Crystals

TABLE SALT



SUGAR

SNOW

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**
- a **comparison** against a **specified *(known)* quantity**
- **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?

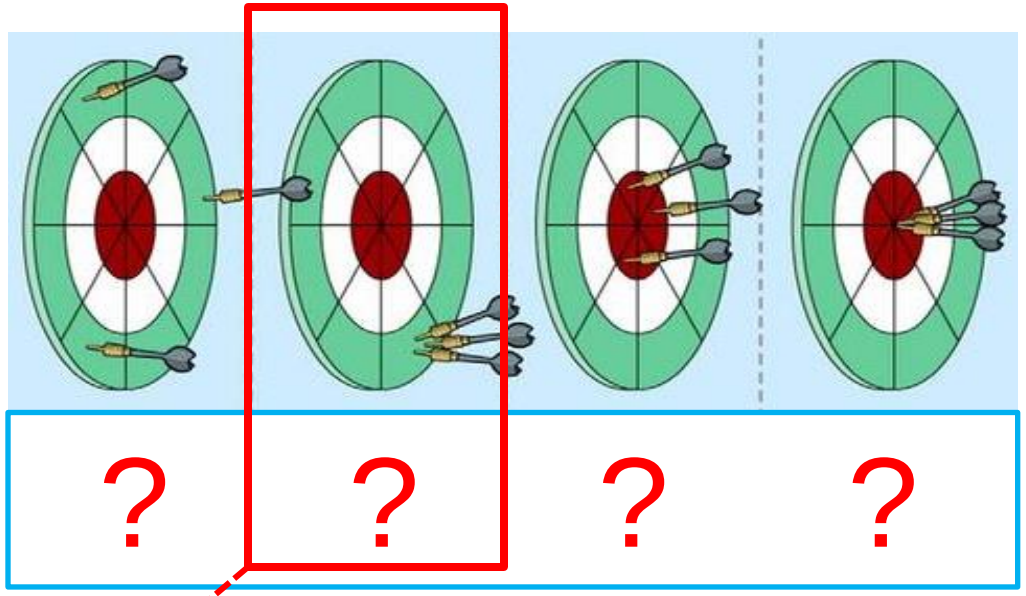
Why do we measure?

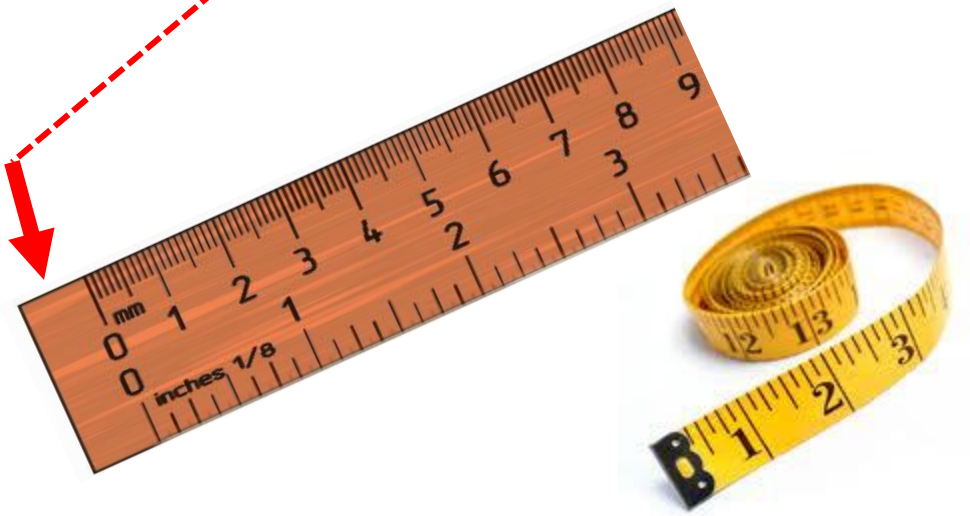
How can we measure?

How well can we measure?

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

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

SOLUTION: Standard Measurement Systems!

What is a System of Measurement?

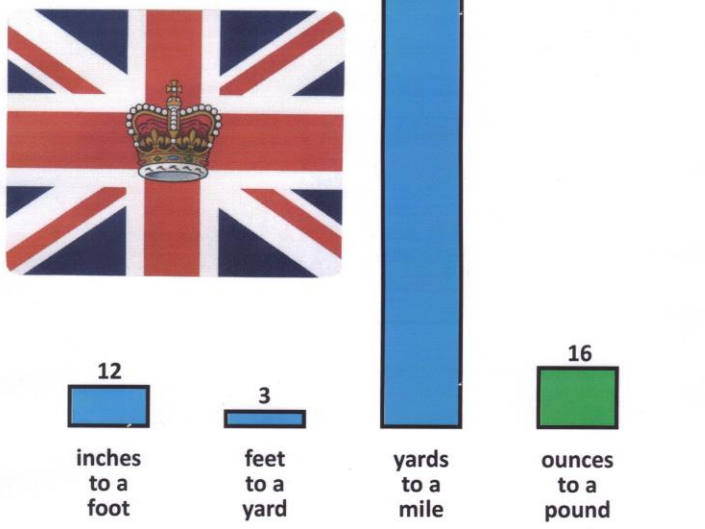
A system of measurement is a collection of units of measurement and rules relating them to each other.

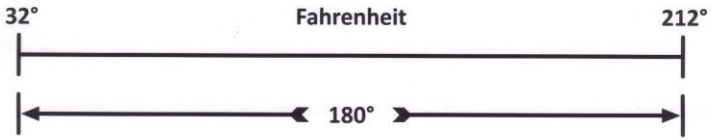
- Must have **base units** defined for all major quantities that need to be measured (example: a *foot*).

- 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 commerce and *science*.

US Customary/Imperial





Metric