

Lecture #1: Measurements in Physics

Base Quantities: Length, time, and mass.

Base Units: meter, second, kilogram

System Internationale Units or S.I. Units

- Formerly the "metric system" or M.K.S. system (1971)

- Other systems:

 - 1.C.G.S. System (centimeter, grams, seconds)

 - 2.English System (inches, pounds, seconds)

- Common Metric System Prefixes (powers of 10)

kilo- (e.g. kilogram, kilometer) $1000=10^3$ 1 kilometer=1,000 meters

mega- (e.g. mega-meter) $1,000,000=10^6$ 1 mega-meter=1,000,000 meters=1,000 kilometers

milli (e.g. millimeter or mu) 1 millimeter = 10^{-3} m micro- (e.g. micrometer or micron) $1 \mu\text{m}=10^{-6}$ m

Nano (e.g nanometer) $1 \text{ nm} = 10^{-9}$ m

Properties of a Unit Standard

- Easily accessible for users around the globe.

1. Second was originally defined in terms of the rotation of the Earth in one day.

Now defined in terms of frequency of an atomic (Cesium) "Atomic Clocks"

2. Meter was originally defined as the distance between two marks on a standard metal bar in Paris.

Now defined as the distance light travels in a given time.

3. The kilogram or kg was originally defined by a standard mass in Paris.

Now the kilogram is defined in terms of the isotope of Carbon 12.

- The standard should not be variable.

- Independent of spatial location

1. The unit standard of time (and space) should be the same in Paris as in New York. The unit standard of time (and space) should be the same at Alpha Centari star system as it is on Earth.

- **Independent of time**

2. The unit standard of time (and space) should be the same in 1050 as it is in 1012.

Unit Conversion from One System to Another

■ How many minutes are there in one day?

Known: 24 hours = 1 day and 1 day = 60 minutes

$$1 \text{ day} \times \frac{24 \text{ hours}}{1 \text{ day}} \times \frac{60 \text{ minutes}}{1 \text{ hour}} = 1,440 \text{ minutes}$$

$$24 * 60 .$$

$$1440 .$$

■ How many seconds are there in one day?

Known: 24 hours = 1 day and 1 day = 60 minutes, and 1 minutes = 60 seconds

$$1 \text{ day} \times \frac{24 \text{ hours}}{1 \text{ day}} \times \frac{60 \text{ minutes}}{1 \text{ hour}} \times \frac{60 \text{ seconds}}{1 \text{ minutes}} = 86,400 \text{ seconds}$$

$$24 * 60 . * 60 .$$

$$86400 .$$

■ example: S.I. to English

How many inches is equivalent to a distance of 5 centimeters? 2.54 cm = 1 inch (conversion)

$$5 \text{ cm} \times \frac{1 \text{ inch}}{2.54 \text{ cm}} = 1.97 \text{ inches}$$

$$\begin{array}{r} 5 \\ \hline 2.54 \end{array}$$

$$1.9685$$

Derived Units

A derived unit is constructed out of the base units. The base units are more fundamental.

Example: speed is defined

$$\text{speed} = \frac{\text{distance traveled}}{\text{time of travel}} \quad (1)$$

Distance is measured in meters and time is measured in seconds so the unit of speed is meters/second.