

Lecture 2

1

Mod-I : Physics of measurements (Introduction)

Q1 What is Metoology ?

- The word 'Metron' refers to 'measure' in Greek.
 - The knowledge about anything is complete only when it can be expressed in 'Numbers' and something is known about it.
 - For every measured quantity, it must be expressed in its unit.
 - To make sure the unit is followed by all, there must be a universal standard. Various units of various parameters of importance must be standardised.
 - Ex: length can be measured in several forms (unit)
several ways (method)
 - * Preliminary ideas of physical measurements.
measuring means ?
 - ↳ Standards: This are used to reproduce one or several definite values of a given quantity.
 - Ex: Master copy of → 1 kg weight (standard)
→ 15 cm ruler / scale (standard)
→ 1 litre container (standard)

2) Fixed Gauges: These are used to check fixed dimensions, forms and position of product features.
ex: A ring gauge used for measuring external diameter of cylindrical objects.

3) Measuring Instruments: These are used to determine the values of measured quantity.
example: ① Weighing machine (Bathroom Scale)
Kitchen Scale.

② Inch tape

③ multimeter (Ameter, Voltmeter etc.)

Q: Define 'physical measurement' with an example and explain its significance (need)?

(Ans) A physical measurement could be defined as the act of deriving quantitative information about a physical object or action by comparison with a reference.

The three important elements of measurement

a) Measurand: Physical quantity or property like ex: length, Angle, Weight

b) Comparator: Comparing measurand with some reference to render a judgement using 'reference'

like Standard meter scale, Standard 1kg weight
Standard Protractor.

③ Reference: The physical quantity or property to which the comparison is made.

A mechanic has to measure the length of a table

steps of the measurement:

- 1) Lay the ruler on the table
- 2) Carefully align the zero of ruler to the one end of the table
- 3) Finally compare the length of the table (measured) with marking on his ruler (reference) by eye
(comparator)

length of table : measured

Ruler : Reference

Eye : comparator

* Important terms and definitions

1) Principle of measurement:

Quantitative comparison of physical quantity with a standard unit.

ex: Voltage measurement using multimeter
Measuring distance with laser.

2) Error of measurement:

Difference between the measured value and true value.

ex: Zero error

Note: Here error pertains to measurement not to an instrument (may be it has been arrived due to faulty instrument or uncalibrated instrument).

3) Correction: Adjustment made to account for known error's. The correction is numerically equal to the error, but opposite in sign.

ex: Subtracting the zero error in scale.

4) Correctness of measurement: How close the measured value is to the true value.

ex: A thermometer calibrated to give accurate readings at specific temperatures.

Q) How does a thermometer designed & calibrated?
→ discussion on ancient methods

5) Reliability of measurements: Consistency of measurements under the same conditions. ie Repeated measurements producing similar result provided the measuring instrument is stable.

ex: Measuring Voltage multiple times under
the same conditions. ③

6) Verification: Process of checking whether the instrument performs as intended.

ex: Verifying the weighing machine with known weights (dumbbell of 5kg, 10kg etc).

7) Calibration: Adjusting the instrument to perfectly align with a standard reference.

ex: ① Calibrating a spectrometer to ensure wavelength accuracy.

② Calibration of thermistors as a function of voltage for digital thermometers.

Lecture - 3 : Measuring Instruments

* Measuring instruments are measuring device that transforms the measured quantity (or related quantity) into a indication or information

* Measuring instruments can either directly indicate the value of measured quantity ex: Voltage from multimeter OR the instrument can indicate its equality to a known measure of the same quantity