What is measurement?

→ The word measurement tells us about the property of something like how long an object is, how heavy an object is etc.

→ measurement provide us with a means of describing various phenomena in quantitative terms.

→ measurement is the process by which one can convert physical parameters to meaningful numbers.

→ measurements are always performed with the help of an instrument. These instruments, which are used for measurements, are called measuring instruments.

Some examples of measuring instruments are:-

1):- Ruler → length

2):- weight machine → weight

3) watch → Time

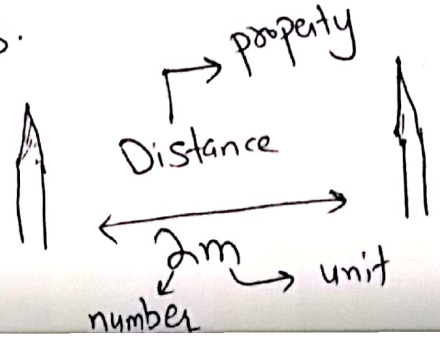
4):- Thermometer → Temperature.

→ The Result of measurement contains two parts:-

a):- number

b):- Unit of measurement

Suppose we want to measure the distance b/w two trees.



Difference b/w measured value and True value:-

Measured value:- Any value calculated from measuring instrument is known as measured value.

True value:- "The actual value of the property being measured is known as True value or Actual value"

→ The results of measurements that we make can vary with different environmental conditions e.g metals expand and contract as the tempretue changes.

error:-

The deviation of measured value (A_m) from true value is (A_T) known as error.

error is denoted by delta (δ)

i.e $\delta = A_m - A_T$

→ error can be positive or negative

a) If $A_m > A_T$ => Error is positive

b) If $A_m < A_T$ => Error is negative.

→ Quality of the measuring instrument is decided by

1. Relative Static Error.

% RSE / % Limiting Error:-

"Relative Static error is the error expressed with respect to true value".

i.e:- $$\frac{A_m - A_T}{A_T} \times 100 \quad \text{---} (1)$$

or $$\frac{\delta_A}{A_T} \times 100$$

eq(1) can be more simplified as:-

$$\left(\frac{A_m}{A_T} - 1\right) \times 100$$

Q:-

Inst. A	Inst B
$\delta_A = 1A$	$\delta_B = 10A$
$A_T = 2A$	$A_T = 1000A$

Find out which instrument has more quality:-

Soln:- We know that the quality of an instrument can be decided by % RSE:-

$$\% RSE = \frac{\delta_A}{A_T} \times 100$$

For Inst A $\% LE = \frac{1}{2} \times 100 = \boxed{50\%}$

For Inst B $\% LE = \frac{10}{1000} \times 100 = \boxed{1\%}$

That instrument, which has low % LE will have best quality.
Hence Inst B has best quality.

Accuracy and Precision:-

Accuracy:-

"Accuracy refers to the closeness of a measured value to actual value"

For example, If in lab you obtain a weight measurement of 3.2 kg for a given substance, but the actual weight is 10kg, then your measurement is not accurate because your measurement is not close to the actual value.

Precision:-

"Precision refers to the closeness of two or more measurements to each other"

Using the example above, if you weigh a substance five times and get 3.2 kg each time, then your measurement is very precise.

Remember, precision is independent of accuracy. You can be very precise but inaccurate. Also, you can be accurate but imprecise.

Example 1:-

John measures the amount of tea in his mug four times. He obtains the following results:- 100mL, 101mL, 102mL, 101mL. The actual amount of tea in the mug is 120mL.

Hence in this case accuracy is poor but precision is good as the readings are close to each other.

→ If we repeat the measurement several times and each time we get the similar reading, then the instrument possess a high degree of precision.

Example 2:-

The value of a Resistor is 20Ω. A student measures the resistance of the resistor four times using multimeter and obtain the following results

1):- 20Ω, 19.3Ω, 18.8Ω, 18.6Ω

Ans:- Accuracy is good
precision is poor

3):- 16Ω, 16.1Ω, 16.0Ω, 16.2Ω

Accuracy is poor
precision is good

3):- 20.1Ω, 20.0Ω, 20.2Ω, 20.1Ω

Accuracy is good
precision is good

4):- 18.6Ω, 17.8Ω, 15.6Ω, 16.2Ω

Accuracy is poor
precision is poor.