2. It can be applied to power functions only.
3. It can not be applied to logarithmic, trigonometrical and exponential functions.
4. It gives no information about direction.

Accuracy, Precision & Error :-

* **Accuracy** :- The accuracy of a measurement is a measure of how close the measured value is to the true value of the quantity.

* **Precision** :- It is repeatability of a measuring process, when a number of measurements are carried out for a single quantity in identical condition.

* Difference b/w Accuracy & Precision :-

Accuracy	Precision
1. It is the agreement of the result of measurement with the true value of measured quantity.	→ It is repeatability of the measuring process.
2. It is concerned with the true value.	→ It has no concerned with the true value.

3. It can exist for only one measurement.	→ It exists only when a set of measurement is carried out.
4. Accurate measurement may not be precise.	→ Precise measurement may not be accurate.
5. Example - If a dia of wire is 2.5 mm by measurement it comes 2.5 mm then reading is accurate.	→ If dia of wire is 2.5 mm and readings are 2.49 mm, 2.49 mm, 2.51 mm, 2.52 mm then readings are said to be precise.

* Errors in a measurement :-

The errors in a measurement is equal to the difference between the true value and the measured value of the quantity.

Error = True Value - Measured value

There are different types of error, they are

1. Systematic error.
2. Instrumental error.
3. Random error.

1. Systematic error :- Systematic errors are caused due to the defective setting

or adjustment of the instruments while performing the experiment. These errors tends to be in one direction, either positive or negative.

Example :- If pointer of ammeter or voltmeter is not at zero initially, then systematic error will occur in each reading.

* Instrumental error :- The error arises due to use of imperfect design or calibration of the measuring instrument.

Example :- In vernier Calliper the zero mark of vernier scale may not coincide with the zero mark of the main scale

* Random Error :- The random errors are those errors which occur irregularly or due to unpredictable fluctuations in experimental conditions (eg - unpredictable fluctuations in temp, voltage supply, mechanical vibration of experimental setup etc)

Example :-

When the same person repeats the same observation it is very likely that he may get different readings every time.

~~* Esti~~

* **Estimation of Error** :- Estimation of error means determining the magnitude of error in measurement.

* **Arithmatic Mean or Average value** :- If the values obtained in n measurements are $a_1, a_2, a_3, \ldots, a_n$.

Then, Arithmatic mean.

$$a_{mean} = \frac{a_1 + a_2 + a_3 + \cdots + a_n}{n}$$

$$\Rightarrow a_{mean} = \sum_{i=1}^{n} a_i / n.$$

In absence of any other method of knowing true value, we take arithmetic mean as the true value, This is because it is reasonable to suppose that individual measurements are as likely to over estimate as to underestimate the true value of the quantity.

* **Absolute error** :- The magnitude of the difference b/w the true value of the quantity and the individual measurement value is called absolute error.

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$$|\Delta a_1| = |a_{mean} - a_1|$$

$$|\Delta a_2| = |a_{mean} - a_2|$$

$$|\Delta a_3| = |a_{mean} - a_3|$$

$$|\Delta a_n| = |a_{mean} - a_n|$$

The absolute error, $|\Delta a_1|, |\Delta a_2|, |\Delta a_3|, \ldots, |\Delta a_n|$ are always (+ve)

Mean (or Average) Absolute error :-

It is defined as the arithmatic mean of all absolute error.

ie $\Delta a_{mean} = \dfrac{|\Delta a_1| + |\Delta a_2| + |\Delta a_3| + \ldots + |\Delta a_n|}{n}$

$$\Rightarrow \boxed{\Delta a_{mean} = \sum_{i=1}^{n} \Delta a_i / n}$$

* **Relative Error :-** It is the ratio of mean absolute error (Δa_{mean}) to the mean value (a_{mean}) of the quantity.

ie, Relative error $= \dfrac{\Delta a_{mean}}{a_{mean}}$

ie, Relative error = $\frac{\text{Average (or mean) absolute error}}{\text{Average (or mean) value}}$

Note - Relative error is also known as fractional error.

* **Percentage error** :- When Relative error is expressed in percent, it is called percentage error.

ie Percentage error = $\frac{\Delta a_{mean}}{a_{mean}} \times 100\%$.

ie. Percentage error = $\frac{\text{Av. Absolute error}}{\text{Average value}} \times 100$

$\Rightarrow$ **Percentage error = Relative error x 100%**

* **Significant figures** :- The number of digits which is used to express the value of physical quantity with the accuracy in the measurement is called Significant figure. It is reasonably trustworthy. It depends upon the accuracy of measuring instrument.

Rules for the identification of Significant —

(i) All the non-zero digits are significant-
eg - 135689 → significant figure = 6.

(ii) All the zeros b/w the two non zero digit are significant, no matter where the decimal point is, if at all.

102 — 3
1.002 — 4
3005 — 4

(iii) If the number is less than one (1), the zero on the right of decimal point but to the left of the first non-zero digit are not significant

eg : 0.003208 → sig fig = 4.

(iv) The terminal or trailing zero(s) in a number without a decimal point are not significant-

eg :- 211 m = 21100 cm = 211000 mm.

All have three (3) significant figure.

(v) The trailing zero(s) in a number with a decimal point are significant.

eg:- 2.500 ⟶ 4
0.06700 ⟶ 4

(vi) The power of 10 is not considered in the determination of significant figure.

eg:- 2.500 kg ⟶ 4
2.500×10^3 g ⟶ 4.