

ERRORS IN MEASUREMENT

There are two types of errors

- ① Systematic errors
- ② Random "

① Systematic error → It occurs constantly in an experiment under same conditions. It can be classified as.

a, Instrumental errors → Occur due to the short coming in the instrument,
eg, zero error in a vernier calliper,
screw gauge; backlash error etc.

b, Errors due to Imperfection - i.e. the imperfections in the instrument or apparatus.
eg, loss in heat in the heat experiments.

c, Gross errors - due to the carelessness of the experimenter,
eg, improper adjustment of the experimental set up; computational mistakes etc.

② Random Errors It arise mainly
i) due to small changes in the conditions of the experiment
ii) In correct judgement of the observer in taking reading.

Random error can be minimised by taking the arithmetic mean of a large number of readings of the same quantity.

Method of Expressing the Error.

- a) Absolute error
- b) Mean absolute error (Mean error)
- c) Fractional or relative error
- d) Percentage error

a) Absolute Error

It is defined as the difference between the true value and the measured value of the physical quantity.

$$\Delta a = a - a_{\text{measured}}$$

a = True value of the measured quantity

a_{mean} when the true value is not given
Then $a = a_{\text{mean}} = \frac{a_1 + a_2 + a_3 + \dots + a_n}{n}$

Absolute error in each measurement

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

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

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

b) Mean Absolute Error or Mean error

$$\text{Mean Error } \Delta \bar{a} = \frac{|\Delta a_1| + |\Delta a_2| + \dots + |\Delta a_n|}{n}$$

$$\Delta \bar{a} = \frac{1}{n} \sum_{i=1}^n |\Delta a_i|$$

c) Relative error or Fractional Error

$$\text{fractional error} = \frac{\Delta a}{a}$$

$$\text{d) Percentage error} = \frac{\Delta a}{a} \times 100$$

SIGNIFICANT FIGURES

- ① All the non zero digits are significant
eg. 12.638, has 5 significant figures.
- ② All zeroes between two non zero digits are significant
eg. 100.05 has five significant figures
- ③ All zeros to the right of a non zero digit having no decimal point are not significant
eg. 86400 has 3 significant figures.
But if the zeros arise due to measurement then it is significant.
eg. No. of seconds in a day = $24 \times 60 \times 60 = 86400$ (It has 5 significant figures.)
- ④ All zeros to the right of a non zero digit but on the left of decimal point are significant
eg. 86400.00 has 5 significant figures.
- ⑤ All zeros to the right of decimal point are significant
eg. 56.00 has four significant figures.