# ACCURACY, PRECISION **OF INSTRUMENTS** AND ERRORS IN MEASUREMENT



The result of every measurement by any measuring instrument contains some **uncertainty**.

This uncertainty is called error

Errors are classified in to systematic errors and

random errors

**Accuracy and Precision** 

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

**Precision** tells us to what resolution or limit the quantity is measured

# Systematic errors

The systematic errors are those errors that tend to be in one direction, either **positive** or **negative** 

They are **Instrumental** errors, Imperfection in experimental technique or procedure (**Procedural** errors) and **Personal** errors

# Random errors

These can arise due to random and unpredictable **fluctuations** in experimental conditions (e.g. unpredictable fluctuations in temperature, voltage supply, mechanical vibrations of experimental set-ups, etc)

#### Least count error

The **smallest** value that can be measured by the measuring instrument is called its least count.

LC of Vernier Calipers is 0.01 cm

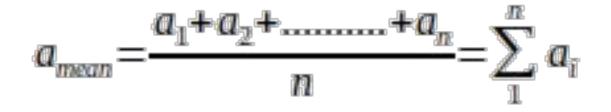
LC of Screw Gauge is 0.01 mm

It occurs with both systematic and random errors

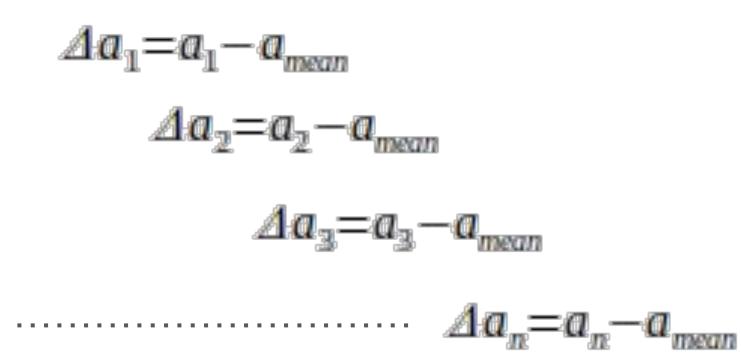
# Absolute Error

If  $a_1$ ,  $a_2$ ,  $a_3$  ....  $a_n$  are the values obtained in different measurements of the same quantity.

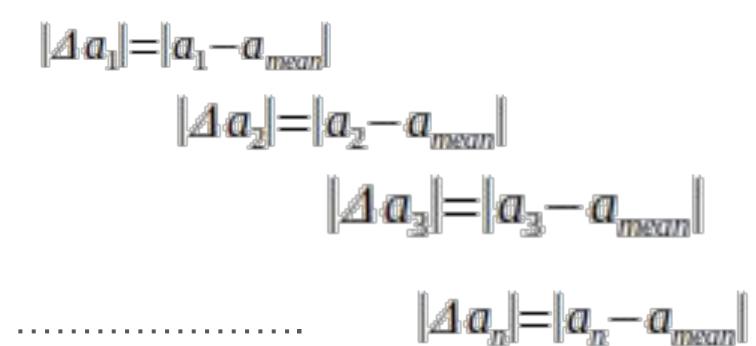
The arithmetic mean of these values is taken as the best possible value (true value) of the quantity



#### Errors on measurements



### **Absolute Errors**



### Mean Absolute Error

The **arithmetic mean** of all the absolute errors is taken as the final or mean absolute error

$$\Delta a_{mean} = \frac{|\Delta a_1| + |\Delta a_2| + |\Delta a_3| + \dots + |\Delta a_n|}{n} = \frac{\sum_{i=1}^{n} |\Delta a_i|}{n}$$

# Range of measured value

It is expected to be in between



# **Relative Error**

The relative error is the ratio of the mean absolute error  $\Delta a_{mean}$  to the mean value  $a_{mean}$  of the quantity measured.

Relative Error = 
$$\frac{\Delta a_{mean}}{a_{mean}}$$

### Percentage Error

#### Relative error can be expressed in percent

Percentage Error 
$$(\delta a) = \frac{\Delta a_{mean}}{a_{mean}} \times 100\%$$