**CHARACTERISTICS OF AN INSTRUMENT**

* **ACCURACY :** The degree to which the result of a measurement, calculation, or specification conforms to the true value. It is normally expressed as % deviation or inaccuracy of the measurement from true value. More commonly it is a description of systematic errors, a measure of statistical bias. ISO defines accuracy as describing a combination of both types of observational error (random & systematic).
* **DEGREE OF ACCURACY :** The degree of accuracy is a measure of how close and correct a stated value is to the actual real value being described. Accuracy may be affected by rounding, the use of significant figures or designated units or ranges in measurement.
* **RESOLUTION :** It is defined as smallest increment in measured quantity that can be detected with certainty by the instrument. Indicates fitness of measurement. High resolution can detect smallest possible variation in input. Normally least count is equal to the resolution. It is the ratio between the maximum signal measured to the smallest part that can be resolved-usually with analog-to-digital (A/D) converter. It is the degree to which a change can be theoretically detected, usually expressed as number of bits. This relates the number of bits of resolution to the actual voltage measurement.
* **PRECISION :** It describes the reproducibility of measurement. If a large number of readings are taken of the same quantity by a high precision instrument, then the spread of readings will be very small. Precise instruments need not be accurate & vice-versa. The values do not have to be true values, they should be just grouped together
* **LENEARITY** : An element is said to be linear if corresponding value of input & output lie on a straight line. The ideal straight line connects the minimum point (Imin, Omin) to maximum point (Imax,Omax) and so it has the equation

**O-Omin = {Omax – Omin / Imax – Imin} \* {I – Imin}**

Linearity is always desirable. It is a measure of the maximum deviation of any calibration points from the reference best fit straight line.

* **UNCERTAINTY OF AN INSTRUMENT** **:** Each instrument has an inherent amount of uncertainty in its measurement. Even the most precise measuring device cannot give the actual value because to do so would require an infinitely precise instrument, A measure of the accuracy of an instrument is given by its uncertainty. As a good rule of thumb, the uncertainty of a measuring device is 50% of the least count. When a quantity is graphed, it is common for the uncertainty of that quantity to be represented by error bars.
* **SENSITIVITY** **:** It is an absolute quantity, the smallest amount of change that can be detected by a measurement. It is the ratio of the magnitude of response (output signal) to the magnitude of the quantity being measured (input signal). Static sensitivity is determined from the result of static calibration.

**Static sensitivity,K =Change in(O/P)signal/Change in(I/P)signal**

Static sensitivity is slope of input-output curve if the ordinates are represented in actual units. If instrument is linear, static sensitivity is constant otherwise varies with input value.

* **DRIFT :** Drift can be defined as a slow change in the response of a gauge. Instruments used as comparators for calibration. Short term drift can be a problem for comparator measurements. The cause is frequently heat build-up in the instrument during the time of measurement. It is the variation of output for given input caused due to change in sensitivity of the instrument to certain interfering inputs like temperature, component instability, humidity. Electronic instrument with electron tubes drift considerably for first 15 minutes. This error can be minimized by switching on instrument 30 minutes, before use. Temperature of all component is stabilized and drift is minimized.
* **THRESHOLD** **:** If the input to an instrument is gradually increased from zero., the input will have to reach a certain minimum level before the change in the instrument output reading is of a large enough magnitude to be detectable. This minimum value of input necessary to cause detectable output is known as the threshold of the instrument. Main cause of threshold is friction.
* **STABILITY :** Measurement stability is the change in bias over time. It represents the total variation in measurements of the same part measured over time. This variation over time is called drift. We can use a control chart to monitor the stability of a measurement process by measuring a master or control part on the same system over time. As measurements are taken, points within the limits indicate that the process has not changed, and points outside the limits indicate that the process has changed. Knowledge of the equipment and measurement conditions help identify special causes when the system is unstable.
* **CALIBRATION :** Calibration is a comparison between a known measurement (the standard) and the measurement using our instrument. Typically, the accuracy of the standard should be ten times the accuracy of the measuring device being tested. However, accuracy ratio of 3:1 is acceptable by most standards organizations. Calibration checks the accuracy of the instrument and it determines the tracebility of the measurement. It also includes repair of the device if it is out of calibration. For the calibration of the scale, a calibrated slip gauge is used. A calibrated optical flat is used to check the flatness and parallelism.