Mine Surveying

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Errors of Measurement

Errors in measurements: Sources of errors

Classification of errors, systematic-random errors

Principle of Adjustment

Basic terms

Errors of Measurement

A discrepancy is defined as the difference between two or more measured values of same quantity.

However, measurements are never exact and there will always be a degree of variance regardless of survey instrument or method used.

The variances are known as errors and will need to be reduced or eliminated to maintain specific survey standards.

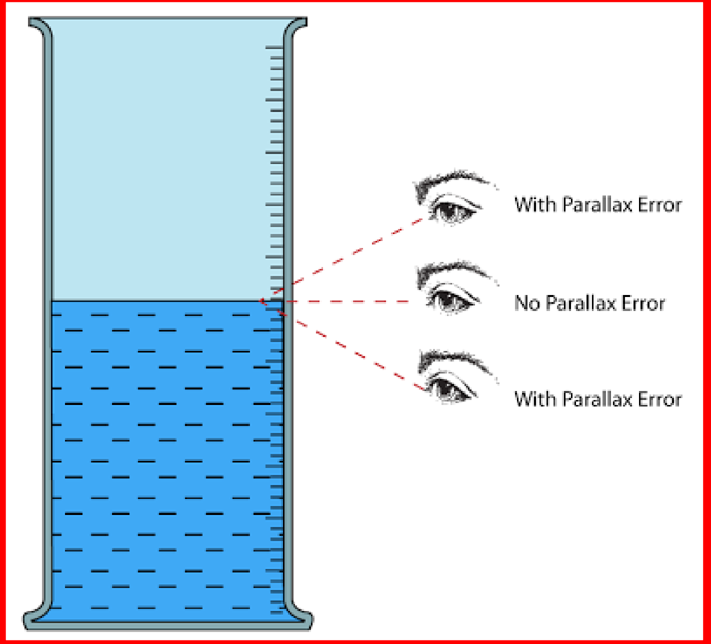
Even when carefully measured, observations may still contain errors. Errors, by definition, are difference between a measured value and its true value.

The true value of a measurement is determined by taking the mean value of a series of repeated measurements.

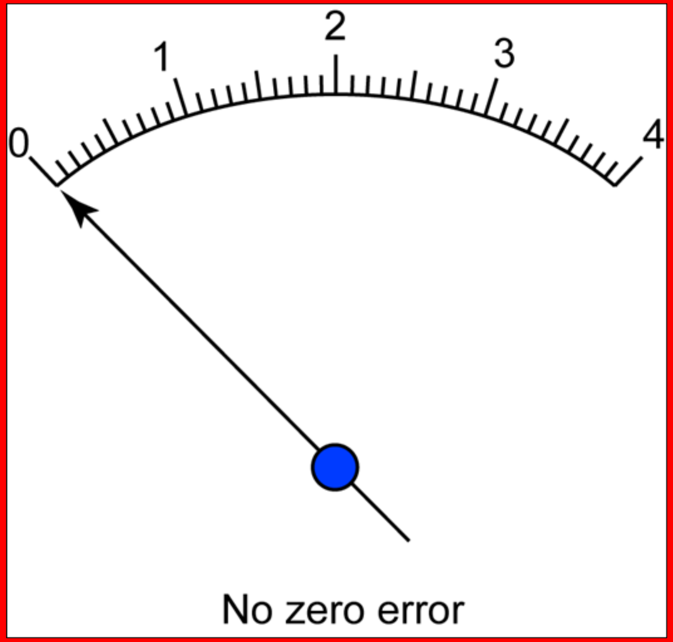
Surveyors must possess skill in instrument operation and knowledge of surveying methods to minimize the amount of error in each measurement.

Sources of Errors

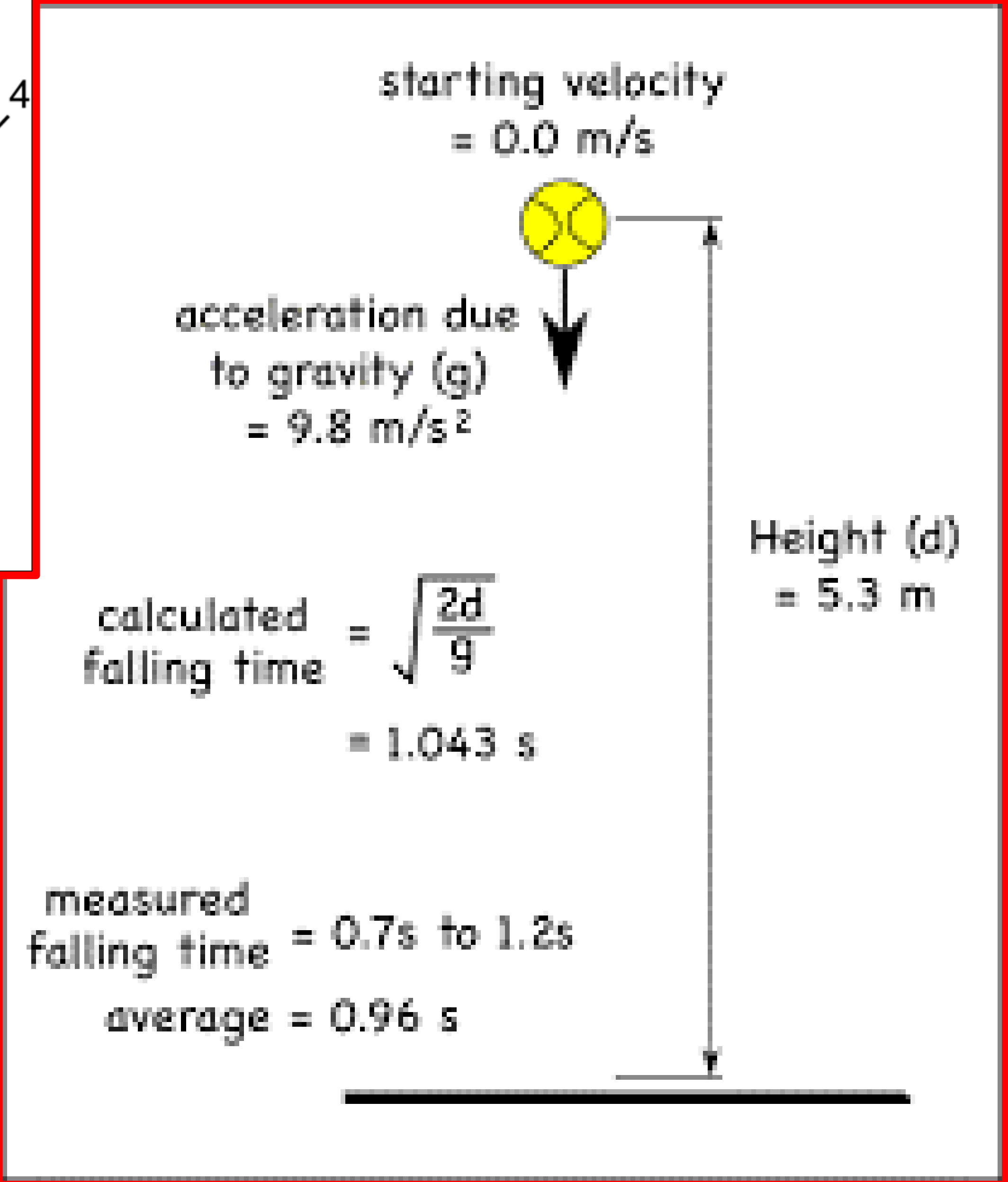
1. **Natural**: These are caused due to variations in nature i.e., variations in wind, temperature, humidity, refraction, gravity and magnetic field of the earth.
2. **Instrumental**: These result from imperfection in the construction or adjustment of surveying instruments, and movement of their individual parts.
3. **Personal/surveyor**: These arise from limitations of the human senses of sight, touch and hearing.



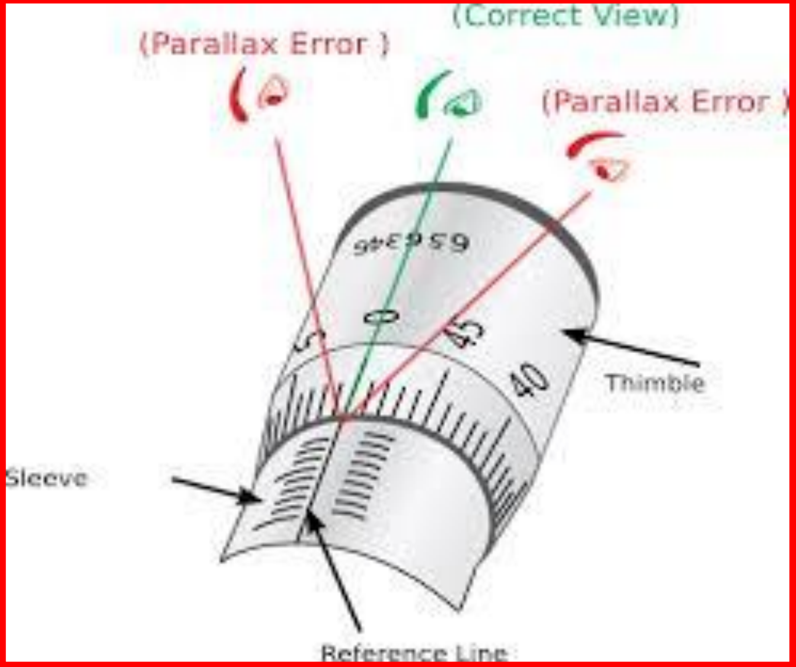
With Parallax Error
No Parallax Error
With Parallax Error



0
1
2
3
4
No zero error



starting velocity
= 0.0 m/s
acceleration due
to gravity (g)
= 9.8 m/s²
Height (d)
= 5.3 m
calculated falling time = √(2d/g)
= 1.043 s
measured falling time = 0.7s to 1.2s
average = 0.96 s



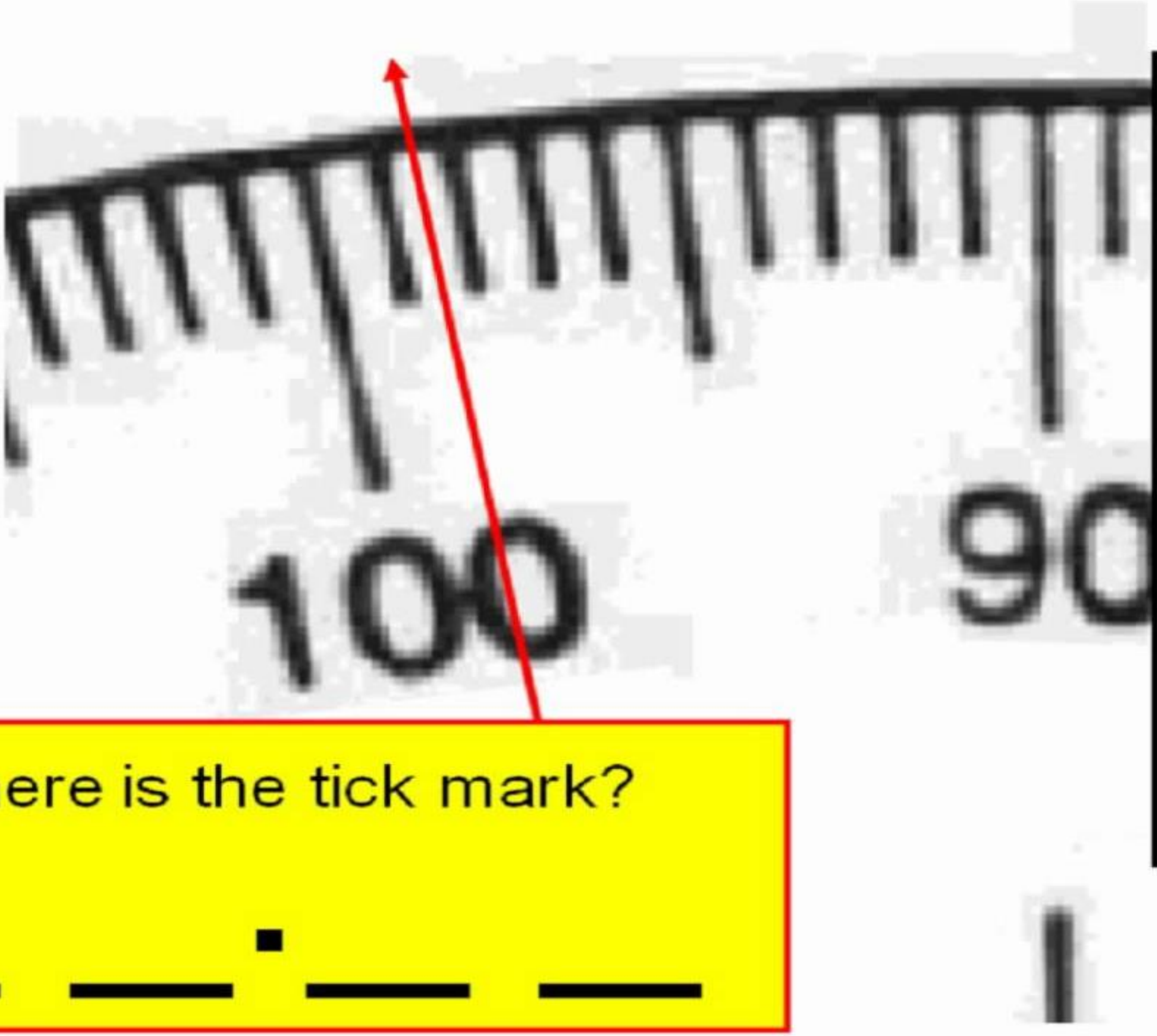
(Correct View)
(Parallax Error)
(Parallax Error)
Thimble
Sleeve
Reference Line

Classification of Errors

A. Blunder/Mistake

A blunder (or gross error) is a significant, unpredictable mistake caused by human error that often leads to large discrepancies.

Blunders are typically the result of carelessness, miscommunication, fatigue, or poor judgment.



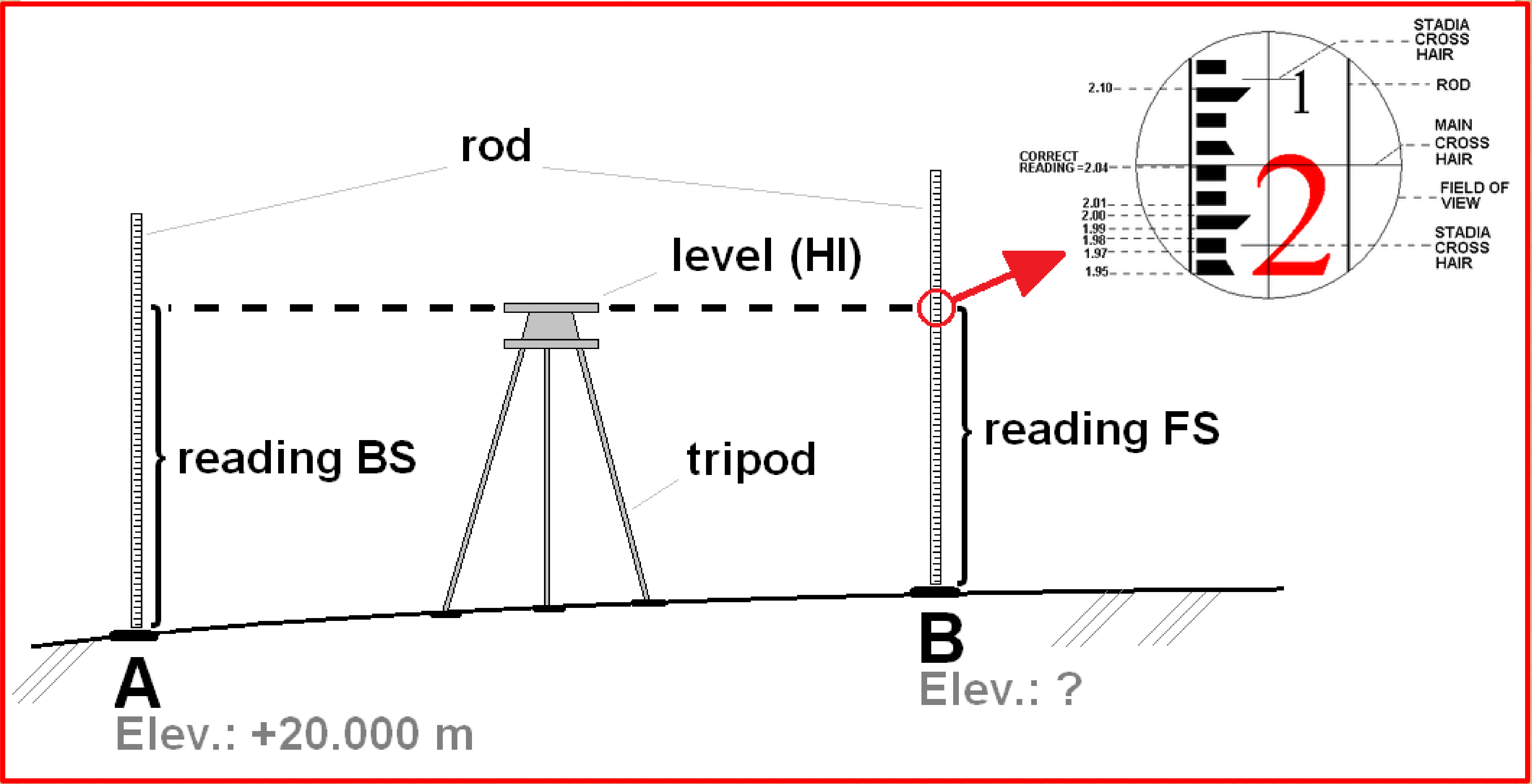
99
97
97.8
98.5
98.51
98.4

Where is the tick mark?

__ __.__ __

Examples of common blunders are-

- ✓ Improperly leveling the surveying instrument.
- ✓ Setting up the instrument or target over the wrong control point.
- ✓ Incorrectly entering a control point number in the data collector.
- ✓ Transposing numbers or misplacing the decimal point.

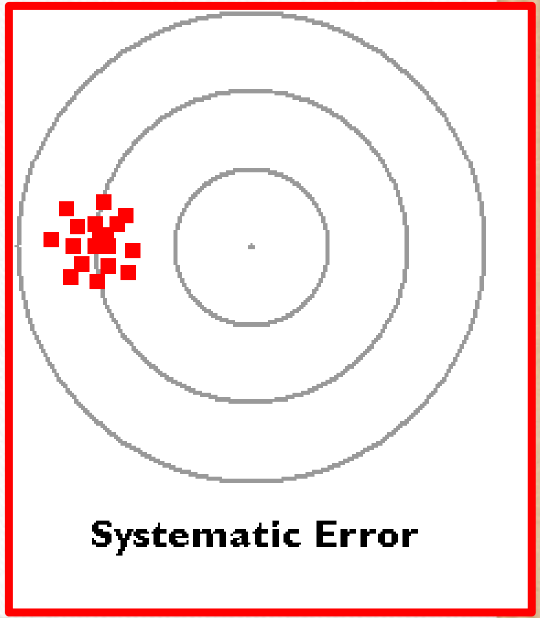

rod
level (HI)
reading BS
tripod
reading FS
A
Elev.: +20.000 m
B
Elev.: ?
STADIA CROSS HAIR
ROD
MAIN CROSS HAIR
FIELD OF VIEW
STADIA CROSS HAIR
2.10
CORRECT READING =2.04
2.01
2.00
1.99
1.98
1.97
1.95
1
2

B. Systematic (Determinate) Errors

The error is reproducible and can be discovered and corrected.

1. ***Instrument errors-*** Failure to calibrate, degradation of parts in the instrument, power fluctuations, variation in temperature etc.

Can be corrected by calibration or proper instrumentation maintenance.

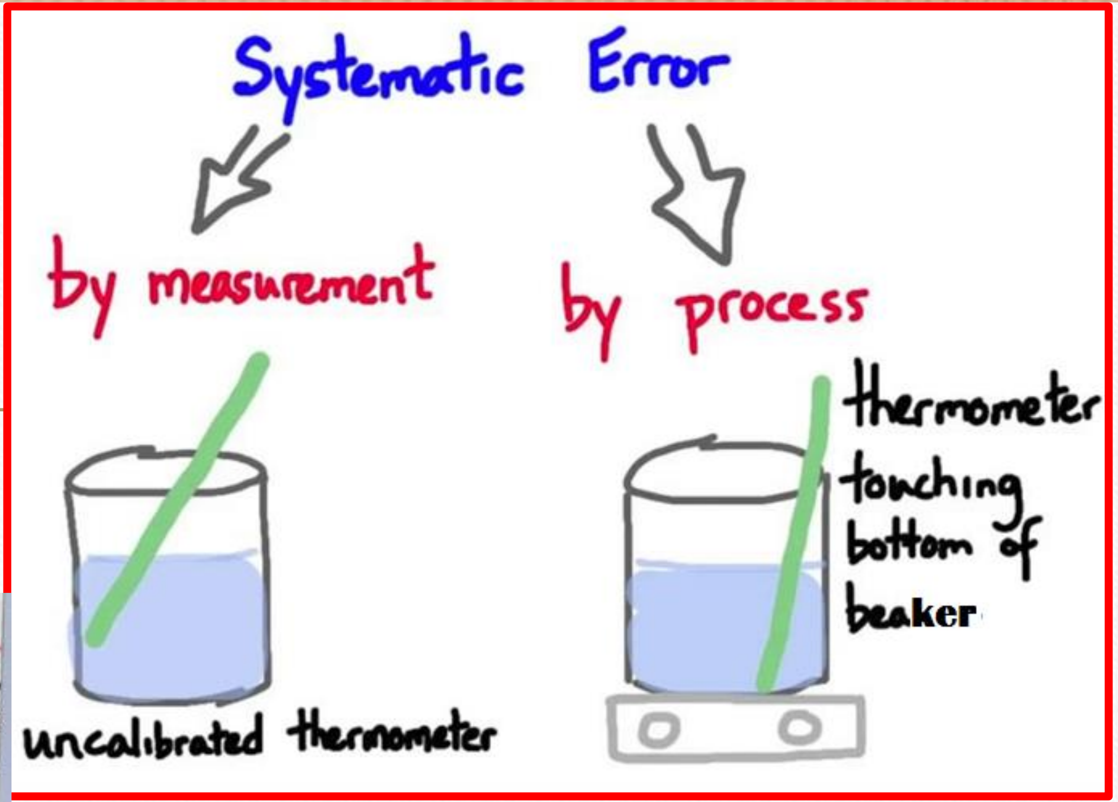


2. ***Method errors-*** Errors due to no ideal physical or chemical behavior-completeness and speed of reaction, interfering side reactions, sampling problems.

Can be corrected with proper method development.

3. ***Personal errors-*** Occur where measurements require judgment, result from prejudice, color acuity problems.

Can be minimized or eliminated with proper training and experience.


Systematic Error
by measurement
by process
uncalibrated thermometer
thermometer touching bottom of beaker

Detection of Systematic Errors

- Analysis of standard samples.
- Independent analysis: Analysis using a “Reference Method” or “Reference Lab”.
- Blank determinations.
- Variation in sample size: detects constant error only

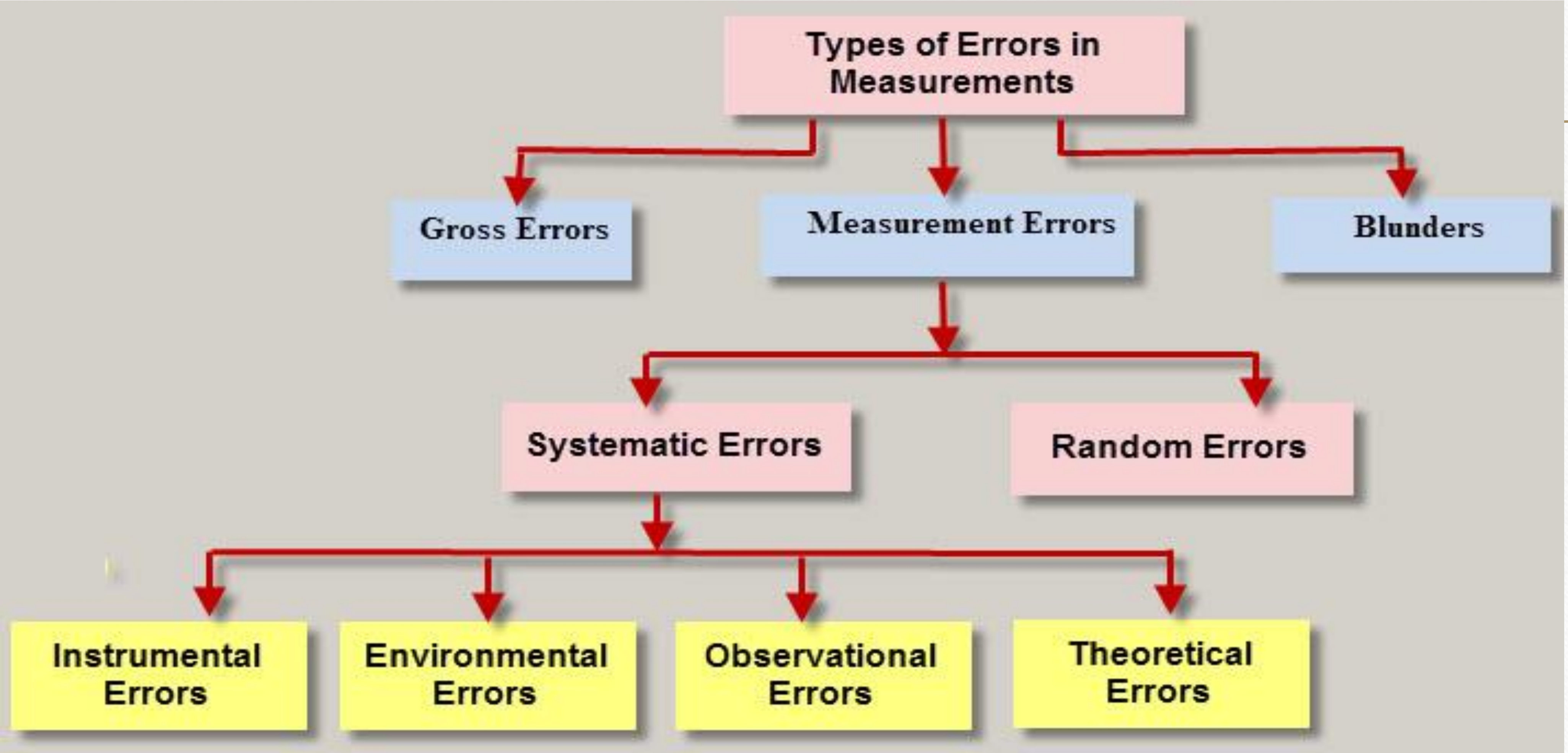
C. Random (Indeterminate) Errors

Caused by uncontrollable variables, which can not be defined/eliminated.

No identifiable cause; always present, cannot be eliminated; the ultimate limitation on the determination of a quantity.

Example-Reading a scale on an instrument caused by finite thickness of the lines on the scale; electrical noise, magnetic field.

Classification of Errors by flowchart



Precision and Accuracy

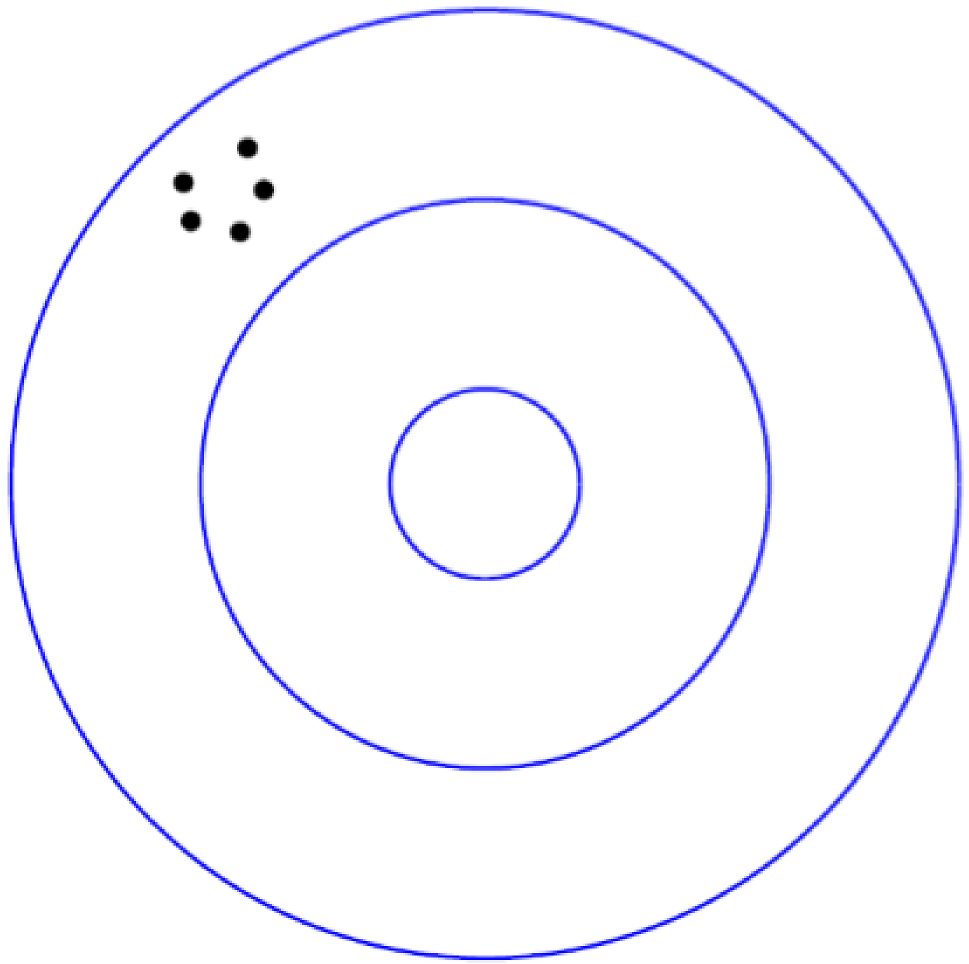
Accuracy and precision are two different, yet equally important surveying concepts.

Accuracy is the degree of conformity of a given measurement with a standard value.

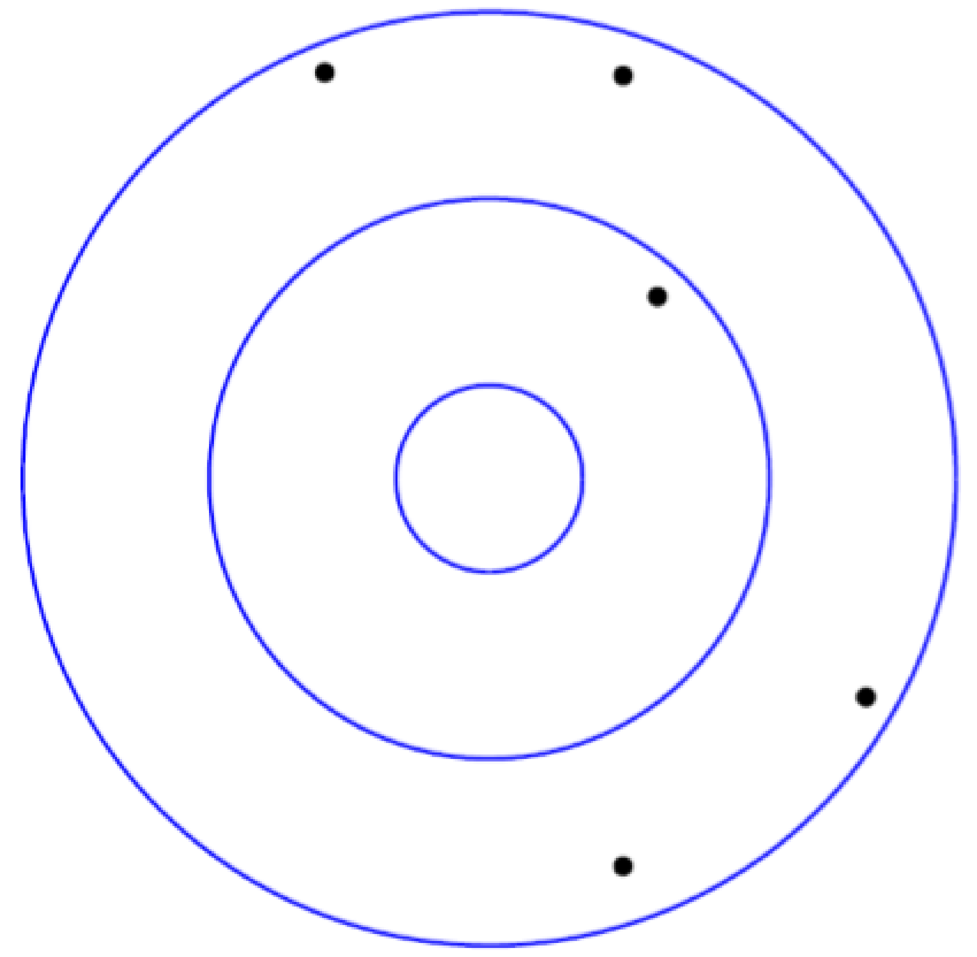
Precision is the extent to which a given set of measurements agree with their mean.

These concepts are illustrated as—

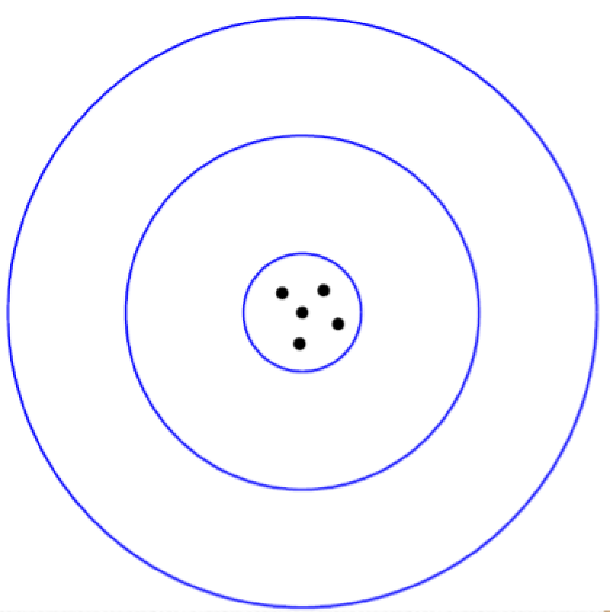
A target shooting example, all five shots are closely grouped indicating good precision due to degree of repeatability. Accuracy is poor……..



A target shooting example, all five shots appear randomly scattered about the target indicating neither accuracy nor precision.



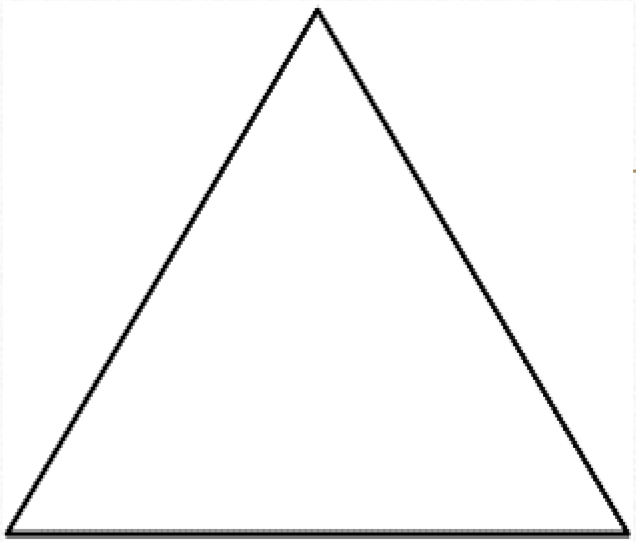
All five shots are closely spaced about the target's center indicating both precision and accuracy.

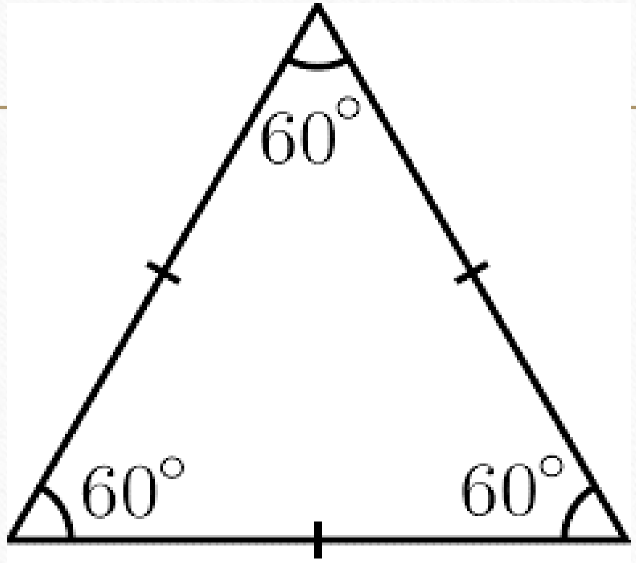


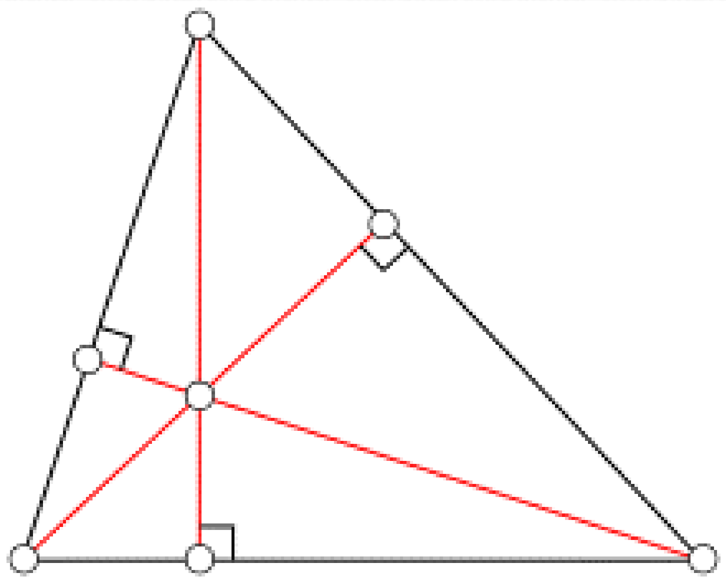
The goal of any survey should be to produce accurate and precise observations.

Often measurements with greater accuracy and precision requirements employ multiple observations to minimize procedural errors.

Principle of Adjustment







Terms

True Error-A true error (E_t) is defined as the difference between the true (exact) value and an approx. value.

True Error (E_t)= *True value - Approximate value*

Relative Error-Relative true error (ϵ_t) is defined as the ratio between the true error and the true value.

Relative Error (ϵ_t)= *True error / True value*

Most Probable value (MPV)-It is the closet approximation to the true value that can be achieved from a set of data. It’s the arithmetic mean of a set.

Arithmetic mean (A)=True value (X)-{Sum of errors $(\sum \epsilon_n)$*/Number of measurements (n)*

Residual-The difference between observed value and the estimated value.

Residual = Observed value - Predicted value

Maximum likelihood to be the nearest of true value