Surveying Engineering

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What is Surveying

- Is the art and science of locate positions of points on or near the earths surface.

Fundamentals of Surveying

Surveying has been important since the beginning of civilization. Its earliest applications were in measuring and marking boundaries of property ownership. Throughout the years its importance has steadily increased with the growing demand for a variety of maps and other spatially related types of information and the expanding need for establishing accurate line and grade to guide construction operations.

Some surveys involve the measurement of distances and angles for the following reasons:

1. To determine horizontal positions of arbitrary points on the earth`s surface.

2. To determine elevations of arbitrary points above or below a reference surface, such as mean sea level.

3. To determine the configuration of the ground.

4. To determine the direction and the lengths of lines.

5. To determine the position of boundary lines.

6. To determine the areas of tracts bounded by given lines.

Importance of Surveying

Surveying is one of the world's oldest and most important arts because, as noted previously, from the earliest times it has been necessary to mark boundaries and divide land. Surveying has now become indispensable to our modern way of life. The results of today's surveys are used to:

1. Map the Earth above and below sea level;

2. Prepare navigational charts for use in the air, on land, and at sea;

3. Establish property boundaries of private and public lands;

4. Develop data banks of land-use and natural resource information that aid in managing our environment;

5. Determine facts on the size, shape, gravity, and magnetic fields of the earth; and

6. Prepare charts of our moon and planets.

Survey works can be divided into four main categories:

1. Ground survey

2. Geodetic surveying: is the science that studies the size and shape of the Earth.

3. Photogrammetry: It is the survey that includes taking measurements from photographs.

4. Cartographic survey: It is the science and art that researches the production of maps.

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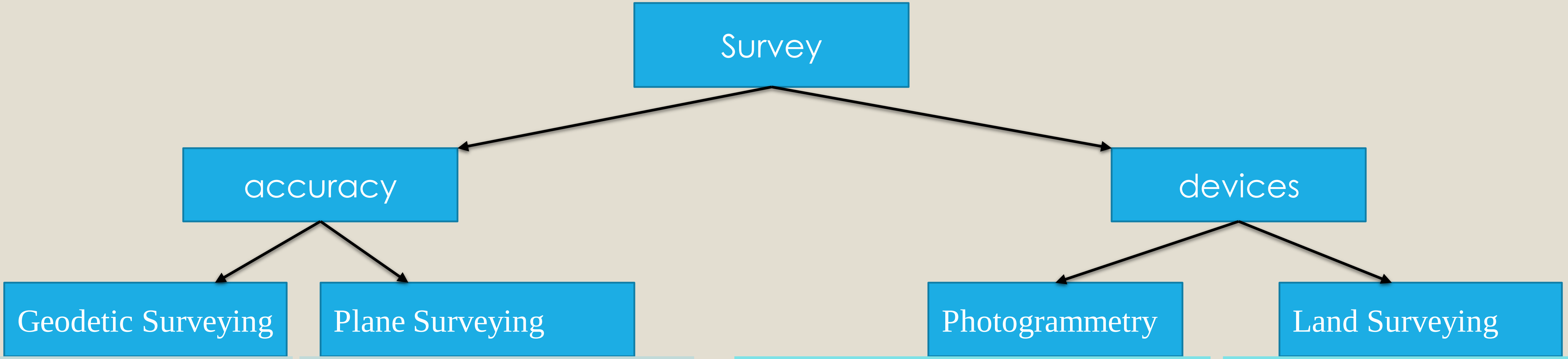


Geodetic Surveying: This type of surveying is the most accurate because it takes in consideration the spherical shape of the Earth, which means it deals with the curvature of the surface.

Plane Surveying: In contrast of the geodetic survey, plane surveying takes in consideration the Earth's surface as being flat not spherical; which means that it neglects the spherical shape of the Earth when determining horizontal positions of points.

Photogrammetry: In this type of surveying several different types of cameras are being used to determine the fielded information required and to perform surveying works instead of using traditional equipment's.

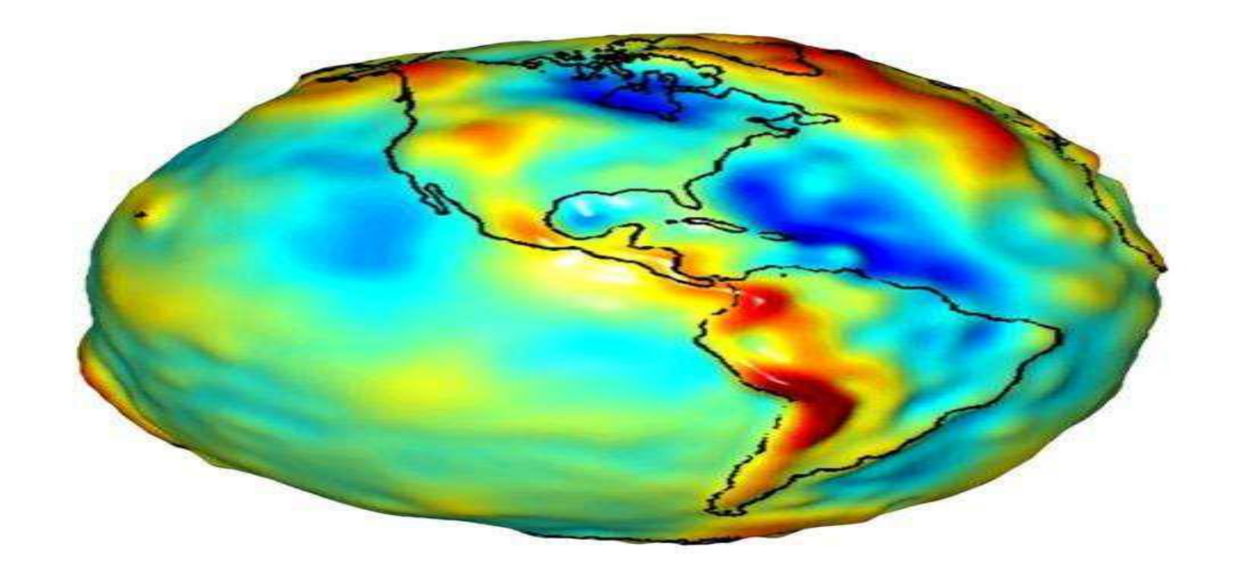
Land Surveying: This type of surveying uses many traditional surveying types of equipment such as the measurement tape, leveling device, the Theodolite and other technological developed devices.

Plane Survey

- Assumes the Earth’s surface to be a plane/ (flat) coordinate system of (x, y) in dimensions (2D).
- Used with construction surveying, water resource ,military surveys, Hydrology surveys, determine legal boundaries and small-area topographic or control surveys.

Geodetic Survey

- Takes into account the true size, shape, and gravity fields of the Earth. In this type of survey , the surface of the earth is considered as a spherical surface, which mean , it takes the sphericality of the earth into consideration, so the geodesic survey is considered one of the most accurate types of survey.
- coordinate of x, y, Z is referenced to datum (MSL).



Land survey

- Land survey: It includes all types of flat area, in which it neglects the convexity of the surface of the earth, which is considered to be a flat surface.

Land survey include the following types :

1. The cadastral survey This type of land survey specializes in defining agricultural properties with a wide scope and in defining residential properties with a limited scope.

2. Topographical survey Gathers data on the location of natural and manmade features, contours, and ground elevation to create a topographic map.

3. Road survey, which is concerned with installing central lines for roads, railways, irrigation channels and drainage, noting that the preliminary surveys of conductors fall within the topographical survey.

4. Urban Survey, which is concerned with defining the central lines of the streets in the city and fixing the locations of water, electricity, telephone and sewage lines.

5. mine survey are performed above and below ground to guide tunneling and other operations associated with mining..

6. Hydrographic survey define shorelines and depths of lakes, streams, oceans, reservoirs, and other bodies of water.

7. Survey of structures This type of survey requires special accuracy in determining the centers of wall lines, displaying foundations and the amount of necessary excavations

8. Engineering survey, which is related to determining the curves of the horizontal and vertical roads, calculating their longitudinal and transverse sections, and calculating areas and volumes.

General Steps of surveying work

From the general definition of surveying every surveying work consist of three main steps:

1. Taking measurements.

2. Performing calculations.

3. Demonstrating the final results as digital information or drawings.

Basic Principles of Surveying

1. Working from “the whole to the parts” to reduce the effect of mistakes or errors made by the devices or the surveyor.

2. Economy of accuracy; which means that when the accuracy is high the costs of the project become higher than it is required to, so the accuracy must fulfill the needs of the project.

3. Surveying work must be characterized by consistency; and that means that the surveyors must use consistent devices of the same accuracy in a project to reduce the errors.

4. Repeating is essential in surveying work in order to check for mistakes and bring the accuracy to the levels required by the project.

Units of Measurement

Magnitudes of measurements (or of values derived from observations) must be given in terms of specific units. In surveying, the most commonly employed units are for *length*, *area*, *volume*, and *angle*. Two different systems are in use for specifying units of observed quantities, the *English* and *metric* systems. Because of its widespread adoption, the metric system is called the *International System of Units*, and abbreviated *SI*.

Metric, or international System of Units (SI)

- Longitudinal units: They are used in measuring dimensions, areas and volumes, and they are on the metric system, noting that the metric system is the one adopted in Iraq and its unit is the meter (m).
- Decimeter (dm) = 0.1 m
- Centimeter (cm) = 0.01m
- Millimeter (mm) = 0.001 m
- Kilometer (km) = 1000 m

Express 75 decimeters as meters

$$\frac{75\,dm}{1} \; x \; \frac{1\,m}{10\,dm} = 7.5\,m$$

Express 1.95 centimeters as millimeters

$$\frac{1.95\,cm}{1} \; x \; \frac{1m}{100\,cm} \; x \; \frac{1000\,mm}{1m} = 19.5\,mm$$

METRIC AREA CONVERSIONS

- Areas are measured in square metric units, such as square meters (m2) and square kilometer (km2). The units used in Iraq to measure agricultural areas are the first, dunums, hectares and their derivatives:
- The first = 100 m2
- A dunum = 2500 m 2 = 25 acres
- Hectare = 10000 m2 = 4 dunums
- Square kilometer = 1000000 m2
- Hectares = 400 acres

Express 84.5 square centimeters as square decimeters

$$\frac{84.5cm^2}{1} x \frac{1m^2}{10000cm^2} x \frac{100dm^2}{1m^2} = 0.845dm^2$$

- These conversions are not all on your sheet but to go from first to second dimension you are squaring measurements from the first….so 10dm in a meter in linear (first) so 100dm2 = 1m2

METRIC VOLUME UNITS

- Express 38,500 cubic millimeters as cubic decimeters

$$\frac{38500mm^3}{1} x \frac{1m^3}{10^9 mm^3} x \frac{1000dm^3}{1m^3} = 0.0385dm^3$$

- Convert 2.5 km3 as cm3

$$\frac{2.5km^3}{1} x \frac{10^9 m^3}{1km^3} x \frac{10^6 cm^3}{1m^3} = 2.5x10^{15}$$

English system

- US survey foot = 0.3048006 m, The US is changing to the metric system
- As for volumes, they are measured in cubic metric units. In the English system, feet, inches, cold and slope are used for dimensions, while acre and square miles are used for areas.
- foot = 12 inches
- cold = 3 feet
- Mile = 5280 feet
- acre = 43560 square feet
- square mile = 640 acre
- 1 ft=12 inch
- 1 inch=2.54 cm
- 1 ft=30.48 cm=0.3048 m
- 1 m=3.2808 ft
- 1 m=39.37 in
- 1 km=0.62137 mile

- Convert 8.24 inch to millimeters

$$\frac{8.24\ \text{in}}{1} \times \frac{2.54\ \text{cm}}{1\ \text{in}} \times \frac{10\ \text{mm}}{1\ \text{cm}} = 209.296\ \text{mm}\ \textit{Ans}$$

- Convert 9.25 ft^2 to square centimeters

$$\frac{9.25\ \text{ft}^2}{1} \times \frac{0.0929\ \text{m}^2}{1\ \text{ft}^2} \times \frac{10\,000\ \text{cm}^2}{1\ \text{m}^2} = 8593.25\ \text{cm}^2\ \textit{Ans}$$

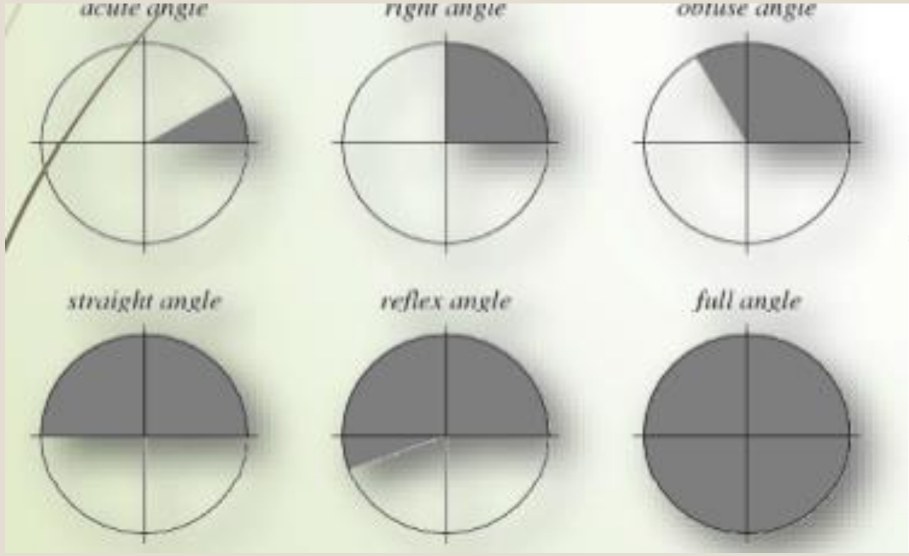
Angular units measurements
وحدات القياس الزاوية

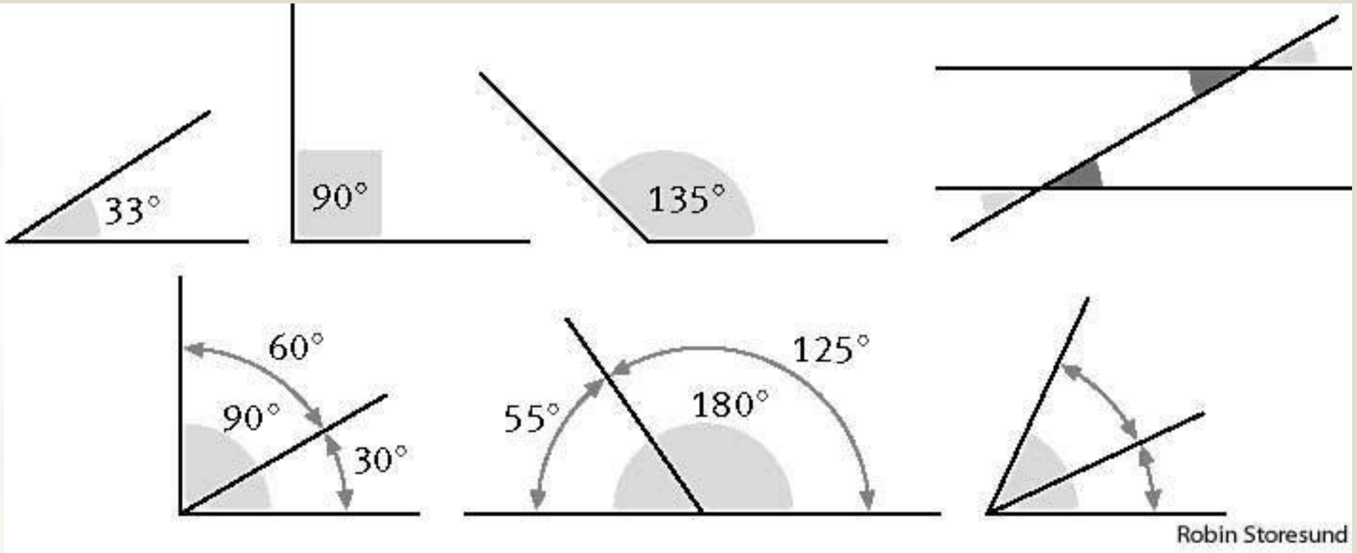
- Angular units: are studied under the topic of angles and directions.

degree System النظام الستيني

Radian Measure النظام الدائري

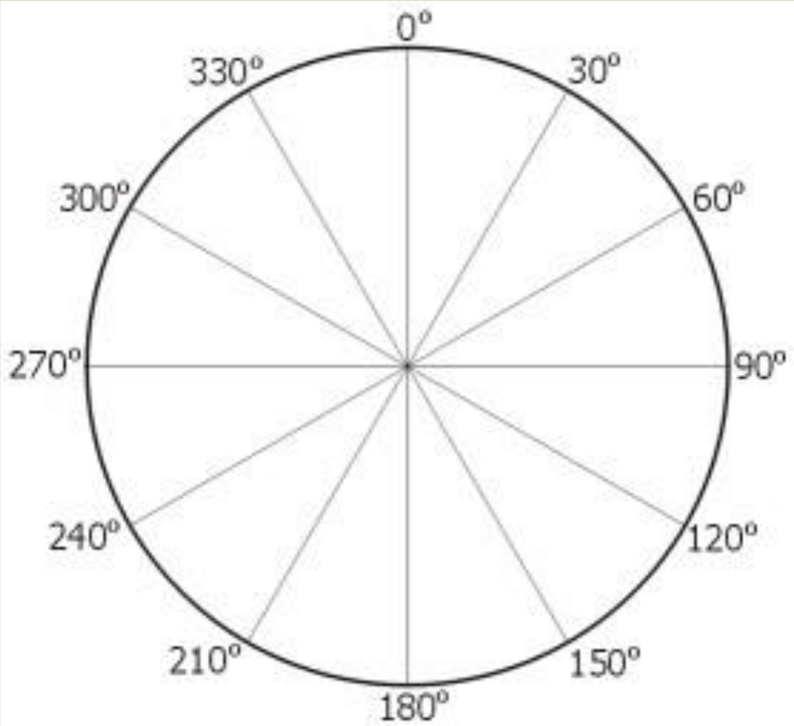
grade System النظام المئوي





Angular units measurements degree SYSTEM

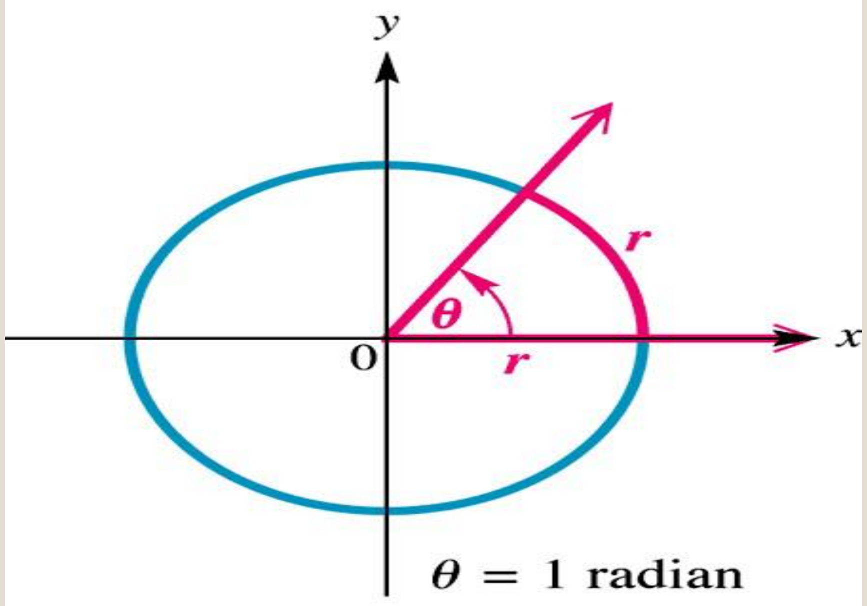
- ❖One degree 1º= 60‘ minute
- ❖One minute 1'= 60'‘ second.
- ❖One second 1''= 100 parts
- ❖Angular units measurements
- ❖Examples:
- ❖16º 50‘30'‘
- ❖51º 45‘ 59'‘
- ❖1º 60‘60'‘
- ❖60º 60‘60'‘ ?



Radian Measure

- The Radian (Rad):
- One radian is defined as the angle at the center of a circle that is subtended by an arc having exactly the same length as the radius.

$$2\pi \text{ rad} = 360^{0}$$
$$\pi \text{ rad} = 180^{0}$$
$$1 \text{ rad} = \frac{180^{0}}{\pi} \approx 57.3^{0}$$



Example : Convert each degree measure to radians

a) 60°

$$60^{0} = 60^{0} \cdot \frac{\pi \text{ rad}}{180^{0}} = \frac{\pi}{3} \text{ rad}$$

b) 221.7°

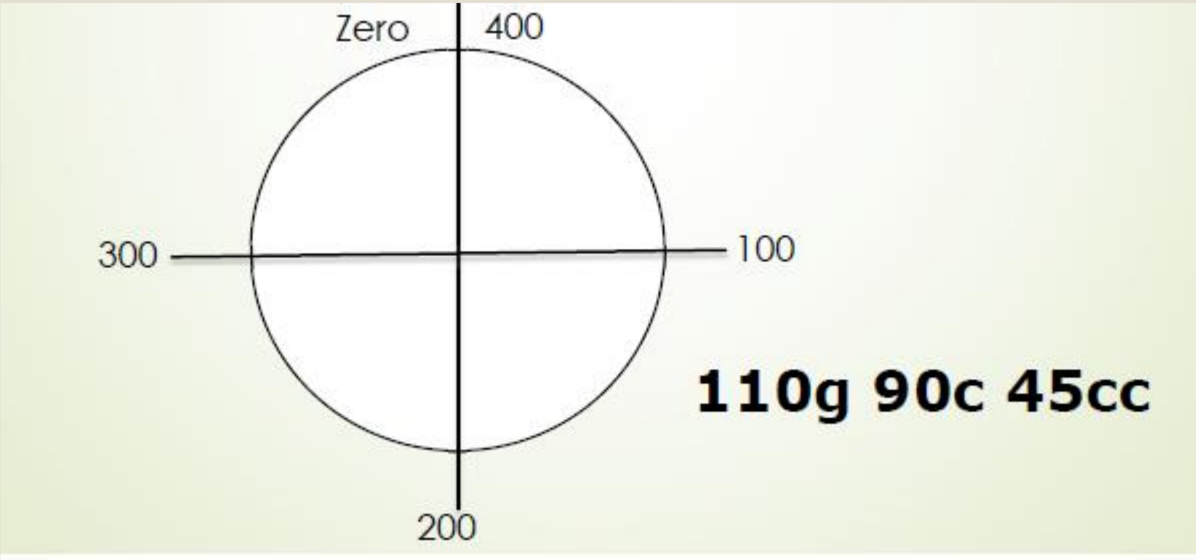
$$221.7^{0} = 221.7^{0} \cdot \frac{\pi \text{ rad}}{180^{0}} \approx 3.896 \text{ rad}$$

Grade System

❖Circumference is divided into 400 grads or grades (400g)

❖One grad is divided into 100 centesimal minutes (1g=100c)

❖ One centesimal minute is divided into 100centesimal seconds (1c=100cc)



End of lecture…
Questions and Answers?

Theory of Errors in Observations

These are observer blunders and are usually caused by misunderstanding the problem, carelessness, fatigue, missed communication, or poor judgment.

Examples include transposition of numbers, such as recording 73.96

instead of the correct value of 79.36ations, …

Characteristics of Measurements

- ❖No measurements are exact.
- ❖ All measurements contain errors.
- ❖The true value of a quantity being measured is never known
- ❖The exact sizes of errors are unknown

Types of Errors

1- Systematic (accumulative)Errors

– Repeated – if identified and modeled, can be easily corrected (Natural errors and Instrumental errors)

2- Mistakes

3- Random (accidental) Errors

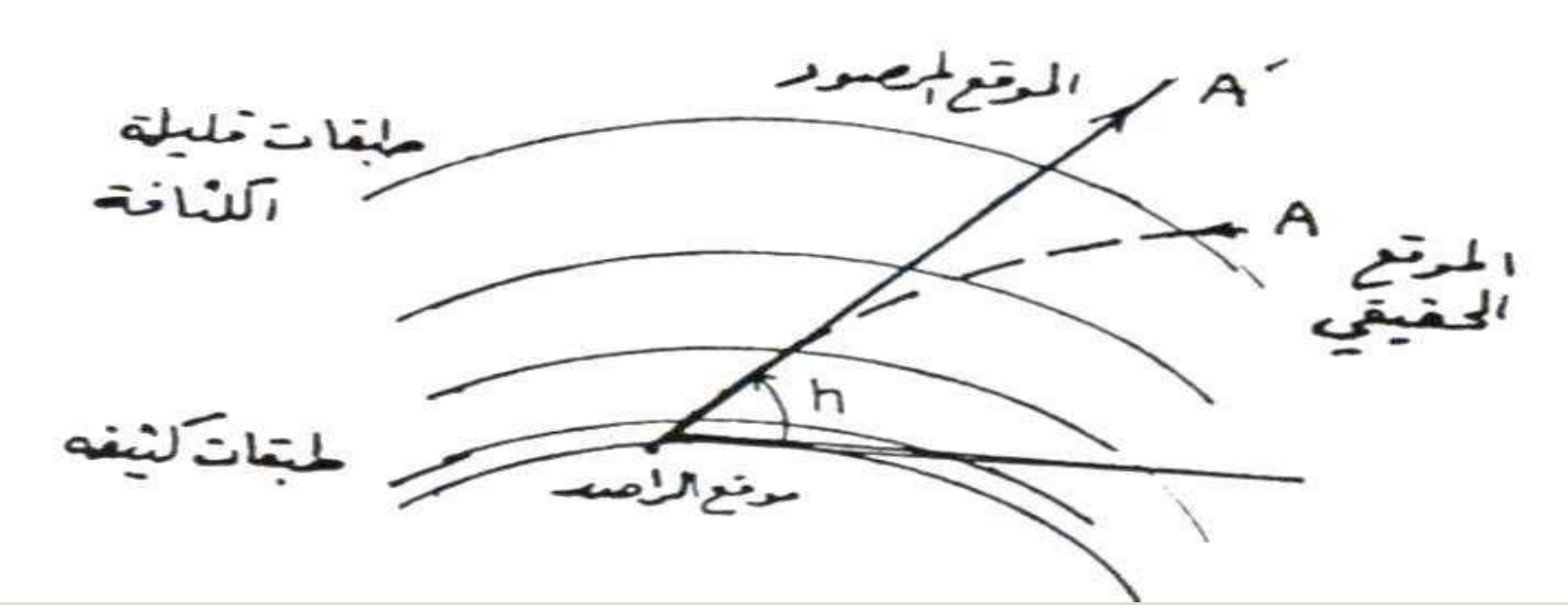
- Occur randomly remain in the measurements after mistakes and systematic errors are corrected.

Sources of Errors

1. Natural errors [Systematic]
2. Instrumental errors [Systematic]
3. Personal errors [Random]

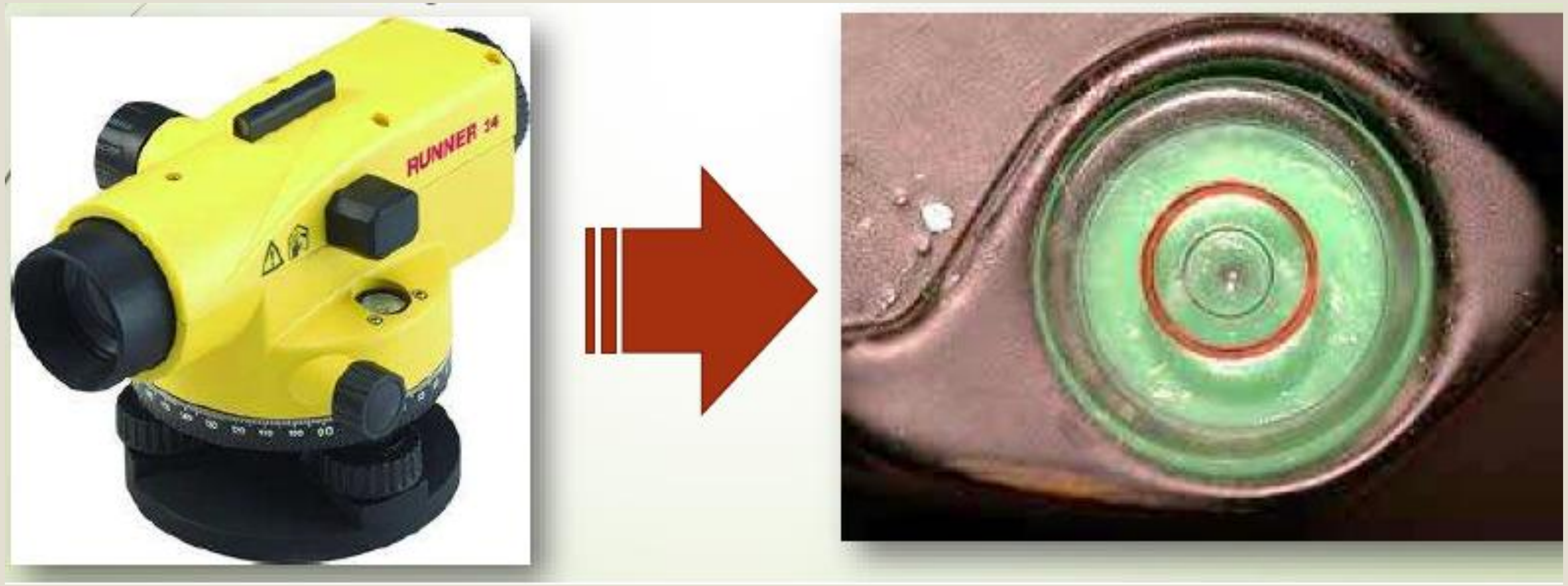
Natural errors [Systematic]

- ❖ Errors caused by conditions in the environment that are not nominal or the differences in atmospheric layers during the observations
- ❖ Examples – temperature different from standard when taping, atmospheric pressure variation, gravity variation, magnetic fields, wind.

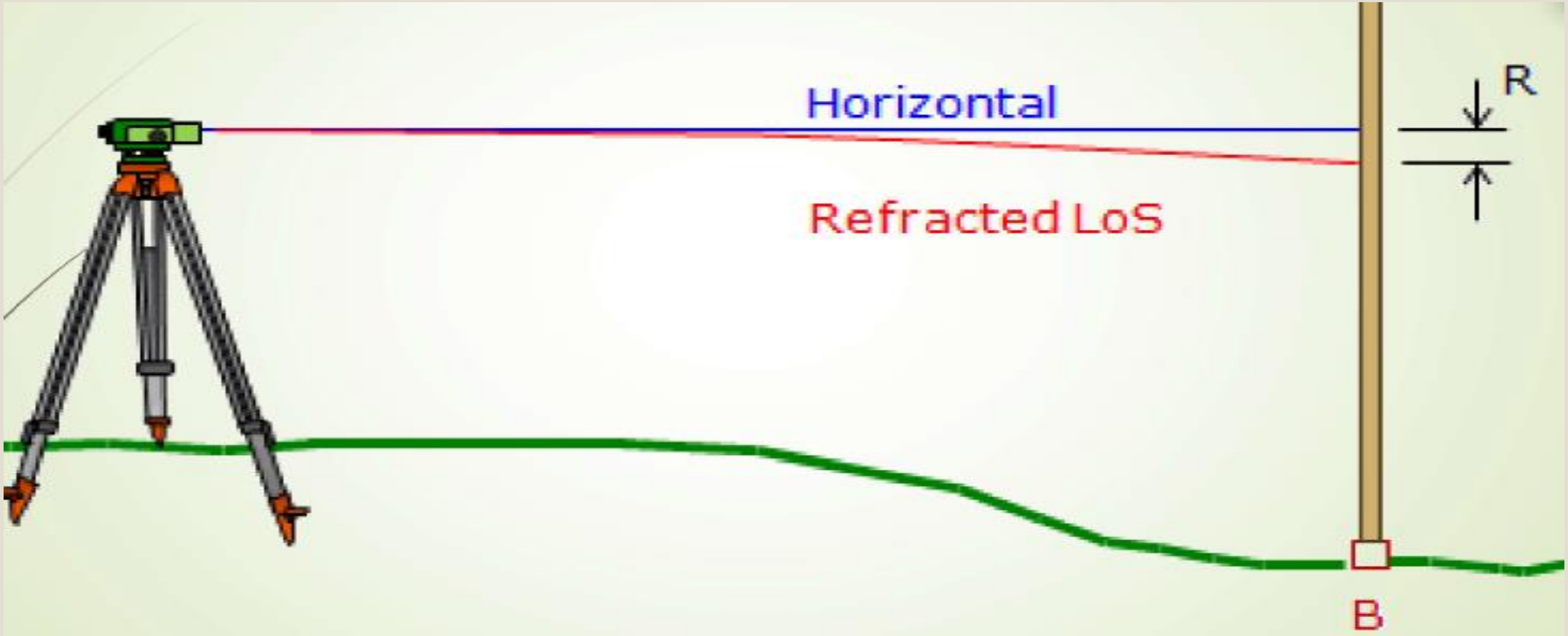


Instrumental Errors

- Caused by imperfections in instrument construction or adjustment
- Examples – imperfect spacing of graduations, nominally perpendicular axes not at exactly 90°, level bubbles or crosshairs misadjusted …



Instrumental Errors



Example of accumulative errors

Used tape length=30m, to measure 3km, then it is found that the used tape is shorter than the standard one by 3mm So, we have here an accumulative errors

3000/30=100
100*0.003mm=3m
3000m-3m=2997m the corrected length

Personal Errors

Errors due to limitations in human senses or dexterity

- Examples – ability to read a micrometer or vernier, steadiness of the hand, estimate between gradution

By definition, an error is the difference between an observed value for a quantity and its true value, or

where E is the error in an observation, X the observed value, $\bar{X}$ and its true value. It can be unconditionally stated that

$$E = X - \bar{X}$$

MISTAKES

There is no thing as mistake in survey. if you make any mistake it is not acceptable.

You can't read between millimeter line with theodolite or leveling.

Examples: south instead of north, or 200 feet instead of 20 feet……..etc.

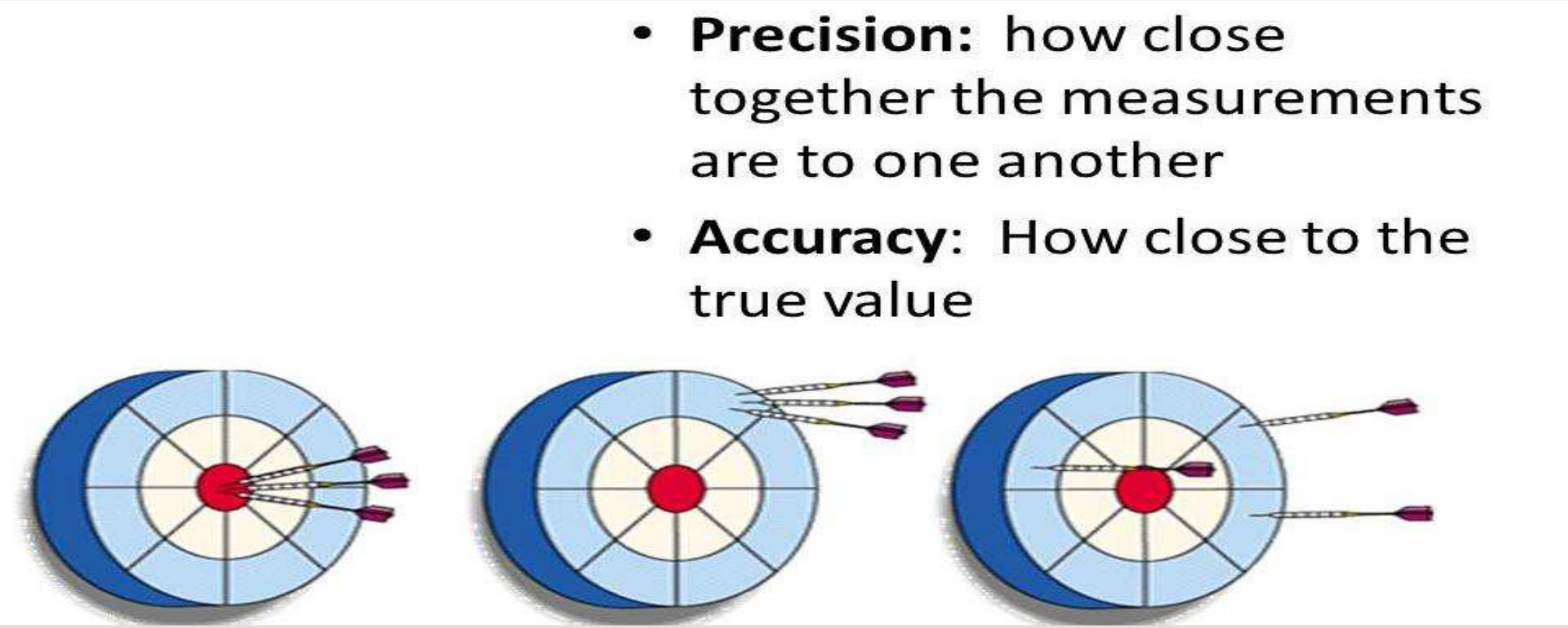
Precision and Accuracy

❖Precision: the degree of consistency of a group of measurements.

❖Accuracy: The absolute nearness of measured quantities to their true values.

The shooting example, Measurements are repeated to a maximum of 16 times,

good observations are both precise and accurate



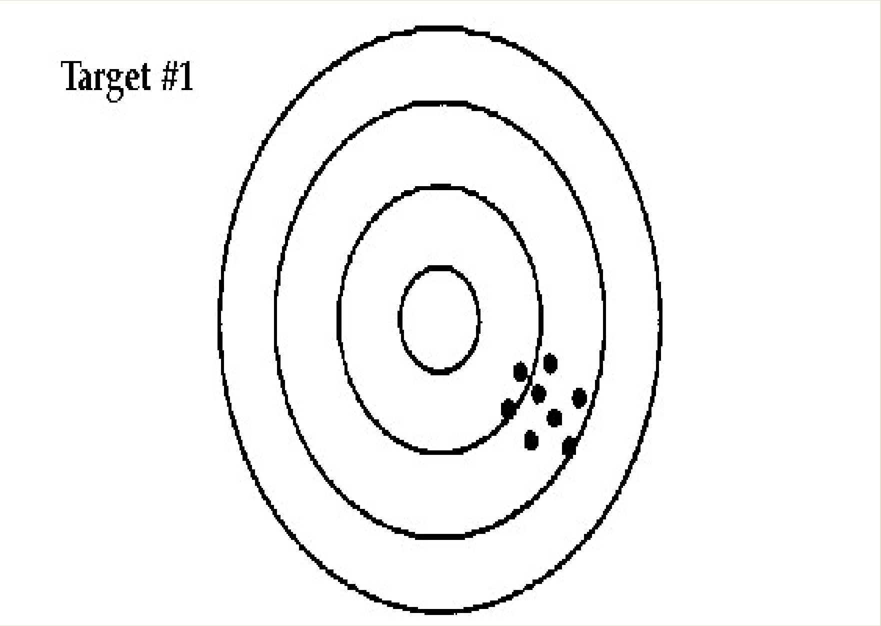
Accuracy and Precision

- Whenever the measured value approaches the real value, the measurement will be accurate. For example, it is said that the line (AB) came with an accuracy of +0.005 meters.
- As for mastery, it is called a specific machine or a specific method of work.
- Note: It is not possible to obtain accuracy without mastering analogies, except rarely, while obtaining mastery without accuracy is a realistic thing that happens very often.

Precision vs. Accuracy

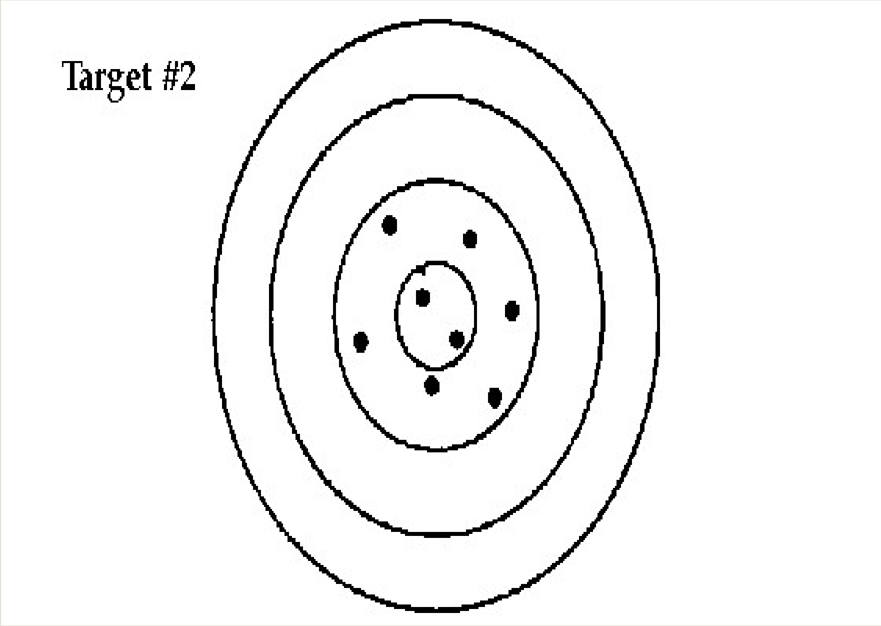
Precision

The “Closeness” of one measurement to another



Accuracy
The degree of perfection obtained in a measurement.

±5m
±0.5m
±0.05m
±0.005m



Computing Precision

$$\text{precision} = \frac{\textit{error of measurement}}{\textit{distanced measured}}$$

- For example, if a distance of 4200 feet is measured and the error is estimated as 0.7 feet, then the precision is:

$$\frac{0.7}{4200} = \frac{1}{6000}$$

Rounding the numbers

Rounding off a number is the process of dropping one or more digits so the answer contains only those digits that are significant. In rounding off numbers to any required degree of precision in this text, the following procedures will be observed:

1. When the digit to be dropped is lower than 5, the number is written without the digit. Thus, 78.374 becomes 78.37. Also 78.3749 rounded to four figures becomes 78.37.

2. When the digit to be dropped is exactly 5, the nearest even number is used for the preceding digit. Thus, 78.375 becomes 78.38 and 78.385 is also rounded to 78.38.

3. When the digit to be dropped is greater than 5, the number is written with the preceding digit increased by 1. Thus, 78.386 becomes 78.39.

25.127	25.13
25.123	25.12
25.125	25.12
25.135	25.14
25.1	25.10

- Example : calculate the average value for the two measured values for the line AB., AB1 = 12.335

  AB2 = 12.338

SOLUTION :

AB mean = (AB1+AB2)/2 = 12.3365

= 12.336