Ethiopian TVET-System

Electro Mechanical Works

NTQF Level - I

Based on March, 2017G.C. Occupational Standard

Module Title: - Carrying Out Measurement And Calculation

TTLM Code: EIS EME1 TTLM 1919V1

This module includes the following Learning Guides

LG 39: Plan and Prepare Tasks

LG Code: EIS EME1 M10 L0 01-LG-39

LG 40: Obtain Measuring Instrument

LG Code: EIS EME1 M10 L0 02-LG-40

LG 41: Carry out measurements and calculation

LG Code: EIS EME1 M10 L0 03-LG-41

LG 41: Maintain measuring instruments

LG Code: EIS EME1 M10 L0 04-LG-42

Instruction Sheet 1	Learning Guide 39: **Plan and Prepare Tasks**

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identifying object or component to be measured
- Obtaining correct specifications from relevant source
- Selecting measuring tools
- Making workstation ready

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify object or component to be measured
- Obtain correct specifications from relevant source
- Select measuring tools
- Make workstation ready

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 14.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the Self-check 1,
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to "Information Sheet 2". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the "Information Sheet 2". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the "Self-check 2"
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the "Information Sheets 3 and 4". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.

12. Accomplish the "Self-check 3"
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation, proceed to "Operation Sheet 1" However, if your rating is unsatisfactory, see your teacher for further instructions or go back to for each Learning Act

Information Sheet-1	Identifying object or component to be measured.

1.1. Introduction to planning measurement

Planning for measurement means preparing the workstation (tools, objects, specification of objects to be measured) so that measurement can be undertaken easily and safely. Before undertaking measurement, the object to be measured should be identified and check its specification. There are many tools used for measurement. The right measuring tool should be used to perform accurate measurement. Take time to plan your work, by yourself and with others. Safety planning is an important part of any task. It takes effort to recognize, evaluate, and control hazards. If you are thinking about your work tasks or about what others think of you, it is hard to take the time to plan for safety. But YOU MUST PLAN! Planning with others is especially helpful. It allows you to coordinate your work and take advantage of what others know about identifying and controlling hazards. While planning your work, what steps you are going to follow, how it is done, the time taken & the materials, tools, instruments needed to finish the work should be clearly indicated.

1.2 Concepts and measurement principles

Measurement: is the assignment of numbers to material things to represent the relations among them with respect to particular properties. The process of assigning numbers is defined as the “measurement process”. The measurement process is the set of operations to determine the value of a quantity.

A process: is an integrated set of activities that uses resources to transform inputs into outputs. In the case of measurement, the requirement or the objective of measurement is the input, while the method employed is the activity that uses the measuring instrument and operator as the resources, to give the output. The value assigned is defined as the “measurement value”. It is also known as the measure and or the result of a measurement value attributed to a measure and, obtained by measurement.

Standard: is a material measure or physical property that defines or reproduces the unit of measurement of a base or derived quantity.

Accuracy: The closeness of the agreement between the result of a measurement and a true value of the measure and.

Precision: The closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement. Precision is also called repeatability.

Reproducibility: The closeness of the agreement between the results of measurements of the same measure and carried out under changed conditions of measurement. The changed conditions of measurement may include:

- ✓ Different measurement principle
- ✓ Different method of measurement
- ✓ Different operator or appraiser
- ✓ Different measuring instrument
- ✓ Different reference standard
- ✓ Different location
- ✓ Different conditions of use at a different time

- **Calibration:** is the set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument, a measuring system or values represented by a material measure, and the corresponding known values of a measure and. Whenever measurements are made, it is with the objective of generating data. The data is then analyzed and compared with requirements so that an appropriate decision can be taken, such as to accept, rework or reject the product. However, unless the measurement data is reliable, decisions based on such data cannot be reliable either. Consequently, these actions contribute enormously to the cost of quality a manufacturer has to bear.

1.3. Units of measurements.

The solution to any practical mathematics problem entails a two-part answer. The first part represents the how many, or the amount, and is always a number. This amount or magnitude is physically meaningless without the second part, which is the what, or unit of the solution. In general, a unit is fixed by definition and is independent of physical conditions. Some examples of units are the foot, pound, degree, ohm, meter, and so on. Each of these is physical unit, which means that it is a subject of observation and measurement.

The early establishment of standards for the measurement of physical quantities proceeded in several countries at broadly parallel times, and in consequence, several sets of units emerged for measuring the same physical variable. For instance, length can be measured in yards, meters, or several other units. Apart from the major units of length, subdivisions of standard units exist such as feet, inches, centimeters and millimeters, with a fixed relationship between each fundamental unit and its subdivisions.

1.4. Fundamental and derived units and their dentitions.

At the time of measuring a physical quantity, we must express the magnitude of that quantity in terms of a unit and a numerical multiplier,

i.e., Magnitude of a physical quantity = (Numerical ratio) × (Unit)

The numerical ratio is the number of times the unit occurs in any given amount of the same quantity and, therefore, is called the number of measures. The numerical ratio may be called numerical multiplier. However, in measurements, we are concerned with a large number of quantities which are related to each other, through established physical equations, and therefore the choice of size of units of these quantities cannot be done arbitrarily and independently. In this way, we can avoid the use of awkward numerical constants when we express a quantity of one kind which has been derived from measurement of another quantity. In science and engineering, two kinds of units are used:

- **Fundamental Units** are the units of the fundamental quantities, as defined by the International System of Units. They are not dependent upon any other units, and all other units are derived from them. In the International System of Units, the fundamental

Table 1.1. Table of fundamental units

Quantity	Base Unit	Symbol
Length	meter	M
Mass	kilogram	Kg
Time	second	S
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Light intensity	Candela	cd
Amount of substance	mole	Mol

- **Derived Units** Other quantities, called derived quantities, are defined in terms of the seven base quantities via a system of quantity equations. The SI derived units for these derived quantities are obtained from these equations and the seven SI base units. Examples of such SI derived units are given in Table,

Table 1.2. Table of derived units

Quantity	Base Unit	Symbol
Area	Meter square	m^2
Volume	Meter cube	m^3
Velocity	Meter per second	m/s
Force	Newton	N
Power	Watt	w
Pressure	Newton per square meter	N/m^2
Acceleration	Meter per second square	m/s^2

1.6. Electrical /electronic units

Units that can be measured in Electrical /electronic include current, voltage, power, resistance, conductance, charge, and frequency.

- **Ampere** (amp or A) is the name given to the transfer of certain number of electrons through a material over a certain elapse time as a result of an electrical pressure. A movement of 6.25 X 10 18 electrons (one coulomb) past a point in 1 second is defined to be 1 ampere of current
- **Electron Volt** is used to state the energy of charged particles, such as electrons, and must not be confused with the volt unit. An electron which is accelerated through a potential difference of one-volt gains one electron volt (v) of energy.

- **Ohm** (Ω) is the physical unit of resistance of a material. One ohm is the amount of electrical opposition that forces an electron movement through a material. One volt across one ohm will result in a current of one ampere.
- **Siemen is** Conductivity of a material is the ease with which it passes electrons. Conductivity and resistivity of a material are inversely related by the formula (G=1/R). The unit of conductance is the Siemen. The symbol used for the Siemen is (S).
- **Watt** is the unit of power or the rate of doing work in an electrical circuit. The power converted in an electrical circuit is 1 watt when energy is converted at the rate of 1 joule-per-second.
- **Coulomb** (Q) is the unit of electrical charge. One coulomb is a charge of 6.25 X 1018 electrons. A flow of one coulomb past a point in one second is one ampere.
- **Hertz** is the number of times an event occurs in a given period. In electrical circuits, frequency is usually given in cycle-per-second. By international agreement, the term Hertz (Hz)has been adopted to mean cycle-per-second.

- **Second is** the standard unit of time is second.

In electronics, measurements may be specified in either the English system or the metric system, and for this reason we must convert from one system to the other system of measurement. However, the metric system is preferred and should be used in all scientific writing. However, since both systems are in current usage, we must learn to convert from one to the other.

1.7. Ranges of Electrical Units

As we noted earlier, electronics is a science which uses very large and very small units, such as a thousand-ohm resistor, a millionth-farad capacitor, a thousand million-cycles-per-second, and soon. To save time in writing and speaking these terms, symbols have been universally adopted to replace those most commonly used terms.

Table 1.3. Table of the most Common prefixes used in Electronics

Prefix	Symbol	Value
Pico	P	10^{-12}
Nano	N	10^{-9}
Micro	µ	10^{-6}
Milli	M	10^{-3}
Kilo	K	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}

Self-Check 1.	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the

Next page:

Part I: **Choose the best answer from the question below**

1. The SI unit of mass, time and current respectively

a. Ampere, kg and second c. volt, mole and ampere
b. Kilogram, second and Ampere, d. kilogram ampere and second

2. The numerical value of the characterization, usually obtained with a suitably chosen measuring instrument is -------

a. type b. uncertainty c. unit d. magnitude

3. The international agreed metric system of units or dimensions is___________

a. SI b. .ms c. bs d. met

Part II. Say true and false for the following question below

_________ 1. Accuracy is not the closeness of the agreement between the result of a Measurement.

_________ 2. The right measuring tool should be used to perform accurate measurement.

_________ 3. The measurement process is the set of operations to determine the value of a quantity.

Satisfactory rating: 6 and above **unsatisfactory rating: Below 6**

2.1. A **geometric shape** is the geometric information which remains when location, scale, orientation and reflection are removed from the description of a geometric object. That is, the result of moving a shape around, enlarging it, rotating it, or reflecting it in a mirror is the same shape as the original, and not a distinct shape

Objects that have the same shape as each other are said to be similar. If they

Also have the same scale as each other, they are said to be congruent.

Many two-dimensional geometric shapes can be defined by a set of points or vertices and lines connecting the points in a closed chain, as well as the resulting interior points. Such shapes are called polygons and include triangles, squares, and pentagons. Other shapes may be bounded by curves such as the circle or the ellipse

Many three-dimensional geometric shapes can be defined by a set of vertices, lines connecting the vertices, and two-dimensional faces enclosed by those lines, as well as the resulting interior points. Such shapes are called polyhedrons and include cubes as well as pyramids such as tetrahedrons. Other three-dimensional shapes may be bounded by curved surfaces, such as the ellipsoid and the sphere

A shape is said to be convex if all of the points on a line segment between any

Two of its points are also part of the shape.

2.2. Different geometrical shapes

Fig 2.1 geometrical shapes

Each geometric shape has its own characteristics by which you can identify and recognize

Geometric Shapes can be defined as figure or area closed by a boundary which is created by combining the specific amount of curves, points, and lines. Different **geometric shapes** are Triangle, Circle, Square rectangle, Rhombus trapezoidal, etc. ... Let us get more idea on basic **Geometric Shapes**.

Circles

A circle is formed when a continuous line (circumference) starts at 0_ and ends at 360_. The **centre** of a circle is that point which is the equal distance of any lines from the circumference of the circle. The **radius** of a circle is the line which starts at the centre of the circle and intersects with the circumference of the circle. The **diameter** of a circle is the line that joins two ends of the circumference and cuts

Through the centre of the circle.

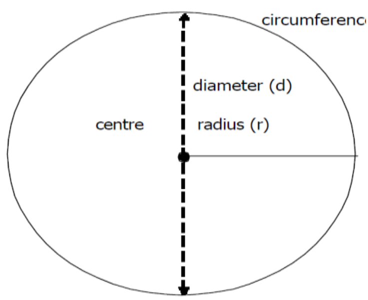


Figure 2.2 circles

Quadrilaterals

Any shape that is formed when four lines meet at different points is called a quadrilateral. The points at which the lines meet is called vertices. We call it a quad for short. ('Quad' means four.) A quad will always have four interior angles because there will be four corners i.e. vertices to create four angles. The four angles always add up to 3600.

Rectangles

A quad with two pairs of opposite sides equal in length and also parallel to each other. All angles are 90_.

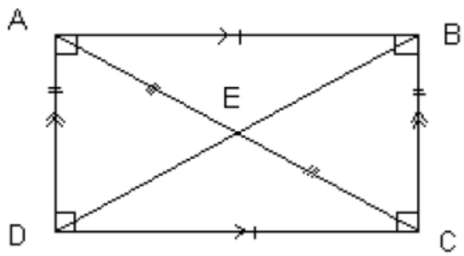


Figure2. 3. Rectangular geometries

AB = DC And AD = BC Opposite sides are equal

AB // DC And AD // BC Opposite sides are parallel

AC = DB Diagonals are equal in length

AE = EC And DE = EB Diagonals cut each other in half

<∠A = <∠B = <∠C = <∠D = 90° All interior angles are 90^0

Parallelograms

A parallelogram is a quad with two pairs of opposite sides equal in length and parallel to each other but no interior angle is a right angle.

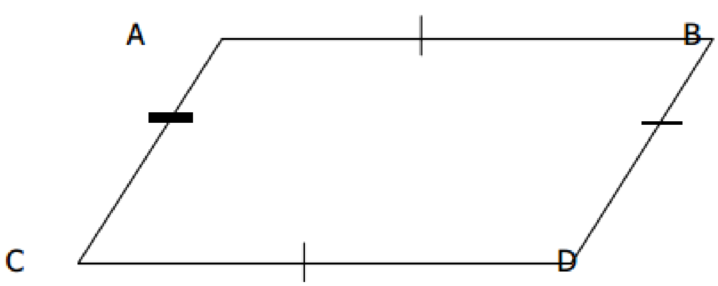


Figure2.4 **Parallelograms**

AB = DC And AD = BC Opposite sides are equal

AB // DC And AD // BC Opposite sides are parallel

AE = EC And DE = EB Diagonals cut each other in half

∠A = ∠D and ∠C = ∠B Opposite angles are equal

Rhombus

A rhombus is a quad of which all four sides are equal in length but none of the interior Angles are equal to a right angle.

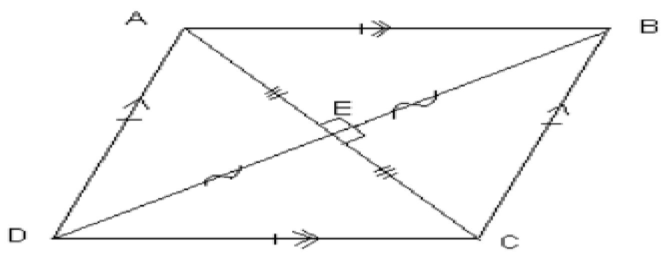


Figure 2.5 **Rhombus**

AB = DC And AD = BC Opposite sides are equal

AB // DC And AD // BC Opposite sides are parallel

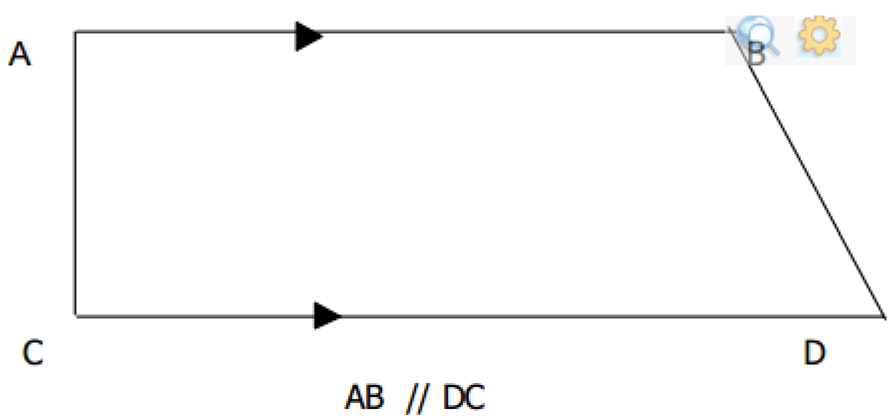
AE = EC And DE = EB Diagonals cut each other in half

∠A = ∠B And ∠C = ∠D Opposite angles are equal

∠AEB = 90 Diagonals cut each other at 90

Trapeziums

Trapeziums (a quad with one pair of opposite sides parallel to each other but not Necessarily equal in length)



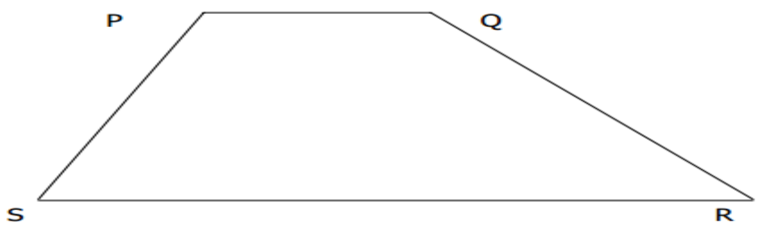


Figure **2.6 Trapeziums**

Sphere: A sphere has no faces. Its shape is like a round ball.

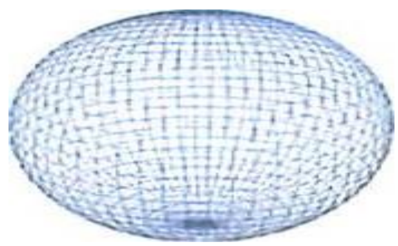


Figure 2.7 **Sphere**

Triangles

When lines meet each other they create shapes. A shape made by three lines is called Triangle. Tri means three; therefore triangle means that there are three angles. Triangles always have three interior angles. Triangles have different characteristics by Which we can identify the different triangles. Angles of a triangle always add up to 1800.

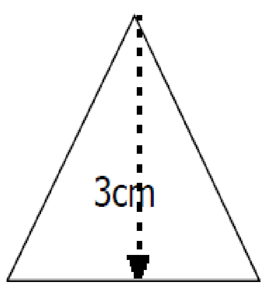


Fig 2.7 Triangle

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Objects that have the same shape and scale is --------
   a. Congruent b. similar c d. ellipse
2. Many two-dimensional geometric shapes are said to be
   a. Polygons b. mono c. a&b d.none
3. A quad with one pair of opposite sides parallel to each other but not

   Necessarily equal in length)

   a. Trapeziums b. triangle c. circle d. none

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information Sheet-3	Obtain correct specifications from relevant source

3.1. Definitions of specification.

It is an exact statement of the particular needs to be satisfied, or essential characteristics that a customer requires (in a good, material, method, process, service, system, or work) and which a vendor must deliver.

Specifications are written usually in a manner that enables both parties (and/or an independent certifier) to measure the degree of conformance. They are, however, not the same as control limits (which allow fluctuations within a range), and conformance to them does not necessarily mean quality (which is a predictable degree of dependability and uniformity). Specifications are divided generally into two main categories:

- **Performance specifications:** conform to known customer requirements such as keeping a room's temperature within a specified range
- **Technical specifications**: express the level of performance of the individual units, and are subdivided into(a) individual unit specifications which state boundaries (parameters) of the unit's performance consisting of a nominal (desired or mandated) value and tolerance (allowable departure from the nominal value, (b)acceptable quality level which states limits that are to be satisfied by most of the units, but a certain percentage of the units is allowed to exceed those limits, and (c) distribution specifications which define an acceptable statistical distribution (in terms of mean deviation and standard Deviation) for each unit, and are used by a producer to monitor its production processes. When completing a job for someone else you should always try and follow every specification so you can get future work from them. You may have to make sure that you follow every specification when you are trying to set up a new factory.

3.2. Sources used to obtain correct specifications.

Published literature is of considerable help in the choice of a suitable instrument for a particular measurement situation. Many books are available that give valuable assistance in the necessary evaluation by providing lists and data about all the instruments available for measuring a range of physical quantities. However, new techniques and instruments are being developed all the time, and therefore a good instrumentation technician must keep **up-to-date** of the latest developments by reading the appropriate technical journals regularly.

3.3 Datasheet

A data-sheet, or spec sheet is a document that summarizes the performance and other characteristics of a product, machine, component (e.g., an electronic component), material, a subsystem (e.g., a power supply) or software insufficient detail that allows a buyer to understand what the product and a design engineer to understand the role of the component in the overall system. Typically, a datasheet is created by the manufacturer and begins with an introductory page describing the rest of the document, followed by listings of specific characteristics, with further information on the connectivity of the devices. In cases where there is relevant source code to include, it is usually attached near the end of the document or separated into another file. Data-sheets are created, stored and distributed via Product information management or Product data management systems. Depending on the specific purpose, a datasheet may offer an average value, a typical value, a typical range, engineering tolerances, or a nominal value. The type and source of data are usually stated on the data sheet. A datasheet is usually used for the commercial or technical communication to describe the characteristics of an item or product. It can be published by the manufacturer to help people choose products or to help use the products. By contrast, a technical specification is an explicit set of requirements to be satisfied by a material, product, or service.

✓ **Product data-sheet information**

A product data-sheet (PDS), like any data-sheet, has a different data model per category. It typically contains:

- Identifiers like manufacturer & manufacturer product code
- Classification data,
- Descriptions such as marketing texts
- Specifications
- Product images
- Feature logos

✓ **Material or Product Safety Data Sheet (PSDS)**

It is an important component of product stewardship and occupational safety and health. These are required by agencies such as OSHA in its Hazard Communication Standard.

It provides workers with ways to allow them to work in a safe manner and gives them physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. There is a need to have an internationally recognized symbol when describing hazardous substances.

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I : Say true and false for the following question below

____1. A product data-sheet like any data-sheet, has a different data model per Category.

____ 2. Specification is an exact statement of the particular needs to be satisfied,or essential characteristics that a customer requires T

____3. **spec sheet** a document that summarizes the performance and other characteristics of a product, machine, component. T

Part II. Choose the best answer from the question below

1. ____________is usually used for the commercial to describe the characteristics of an item or product.

A. information C. Data sheet

B. Product image D. logos

2. ____________is express the level of performance of the individual units

A. Technical specifications C. datasheets

B. Performance specifications D. all

3. ____________are written usually in a manner that enables both parties to measure the degree of conformance.

A. Data sheet C. specification

B. Description D. all

Answer Sheet

Name: ____________ Date: ____________

Score = ____________

Rating:

Satisfactory rating: 3 and above **unsatisfactory rating: Below 3**

Information Sheet-4	Selecting measuring tools

4.1. Introduction to Measuring tools

Measurement of any quantity, like length, mass, time, speed, velocity, pressure, temperature, current, voltage, power, etc., is nothing but comparison of the quantity against some standards. As for example, when we measure the length of a piece of cloth with a meter scale, we only compare a particular length against the standard calibrated scale. Using a meter scale to measure the length of a piece of cloth is the direct method of measurement. In engineering applications, for measurement of a variable quantity like pressure, velocity, temperature, etc., indirect methods are used.

Measuring instrument is a device for measuring a physical quantity. In the physical sciences, quality assurance, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events. Established standard objects and events are used as units, and the process of measurement gives a number relating the item under study and the referenced unit of measurement. Measuring instruments, and formal test methods which define the instrument's use, are the means by which these relations of numbers are obtained. All measuring instruments are subject to varying degrees of instrument error and measurement uncertainty.

The major measuring equipments used in civil works of water supply and sanitation works include: rulers, tape measures, trundle wheels, calculators and others.

a. Methods for selection of measuring instruments (tools)

The selection of measuring instruments (tools) for linear measurements, takes the following main factors into account: manufacturing program, the construction features of the details and manufacturing accuracy – the tolerance zone (IT), measuring instrument error and the measuring costs.

In the single production companies, the special measurement instruments are inapplicable, so it is recommended the dimension’s control of manufacturing products to be made using universal measuring equipment (calipers, micrometers, indicating internal gages i.e.). In the serial production the main measurement testing and control instruments are limit gauges, measurement templates and

semiautomatic measurement instruments. For the selection of measurement instruments the set of metrological, exploitation and economical indices are reviewed. The metrological indices are: scale interval, measurement method, accuracy, measurement range (interval).

The exploitation and the economic indices are the cost and the reliability of measurement instruments, running time before repair is needed, inspection intervals, easy to use, inspection and repair costs including the measurement instrument delivery costs to the place for inspection and back.

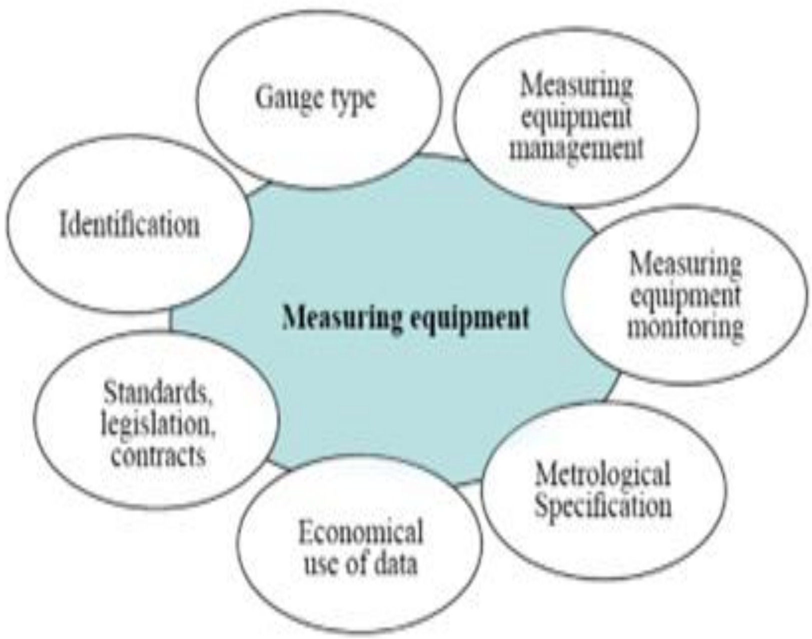


Fig. 4.1. Measuring cycle

Fig. 4.1. shows the required information for the preliminary selection of measurement instruments. The purpose of preliminary selection of measurement instruments is to

Main criteria	Minor criteria	Advanced Minor Criteria
- given measurement task	- in what form the measured values have to be	- type / construction
- measured quantity	- how the values have to be pro-cessed	- environmental conditions
- measured range of the parts	- how the measuring equipment have to be used	- sensors
- the dimensions and tolerances	- who should operate the measur-ing equipment	- control
- available time for tests		- software
		- consulting and services

Fig. 4.2. Criteria for selection of measuring equipment

The starting point in choosing the most suitable instrument to use for measurement of a particular quantity in a manufacturing plant or other system is the specification of the instrument characteristics required, especially parameters like the desired measurement accuracy, resolution, sensitivity and dynamic performance).

It is also essential to know the environmental conditions that the instrument will be subjected to, as some conditions will immediately either eliminate the possibility of using certain types of instrument or else will create a requirement for expensive protection of the instrument. Provision of this type of information usually requires the expert knowledge of personnel who are intimately acquainted with the operation of the manufacturing plant or system in question.

Then, a skilled instrument technician, having knowledge of all the instruments that are available for measuring the quantity in question, will be able to evaluate the possible list of instruments in terms of their accuracy, cost and suitability for the environmental conditions and thus choose the most appropriate instrument. As far as possible, measurement systems and instruments should be chosen that are as insensitive as possible to the operating environment, although this requirement is often difficult to meet because of cost and other performance considerations. The extent to which the measured system will be disturbed during the measuring process is another important factor in instrument choice.

4.3. Types and Uses of measuring tools.

As a technician must be able to identify the types and use of basic measuring and repair instruments (tools) and the basic components of these instruments. The following measuring and repair instruments (tools) are discussed these are rule, straight edge, try square, protractor, combination gauge and torque gauge.

Measuring tools are instruments used to determine lengths and angles. They follow two systems, these are the US customary system and the International System (SI), commonly referred to as metric. US customary rulers and scales measure feet and inches. Smaller units are measured in fractions of an inch (See Fig. 3.3A).To find the fractional distance you need, count the spaces across the board. This becomes the numerator (top number). Count the spaces in one inch on the rule. This is the denominator (bottom number). Metric rulers and scales measure in millimeters. They are typically numbered every 10 mm. See the metric rule in Fig .3.3B. A metric rule may be further divided into 0.5 mm. Both systems may appear on the same measuring tool, as shown in Fig. 3.3. C.

4.4. Common measuring tools and equipments in civil works

- **Scale rule: Scale** is used to interpret dimensions from plans or drawings to full distance. For example, plans may be drawn to scale 1:100. This means that every 1 cm measured on the plan equates to 100 cm measurement in reality. Measurements from plans are often taken with a scale rule. The Scale rule measures the lengths from the drawing and gives measurements in full sizes. These can be used to take lengths not labeled on the plan. Common scales used are 1:100, 1:200, and 1:500.
- **Folding Rule:** These can be one piece up to 1m long or folding. The folding 1m rule is the most commonly used tool for measuring or transferring distances of less than 1m. Non-folding rules are usually made of steel. Folding rules can be made of plastic or wood. You should select only good quality rules.
- **Tape measures:** The most commonly used measuring tool is the tape measure. They may be metal-bladed retractable tapes of 3m to 8m or cloth tapes of up to 30m. **The wind-up tape measure:** is primarily designed for measuring large dimensions, such as the size of a room.

Fig: 4.3 Soft rule (soft tape measure)

Flexible Tape meter: It consists of a ribbon of cloth, plastic, or fiber glass strip with linear-measurement markings. Tape measures that were intended for use in tailoring or dressmaking were made from flexible cloth or plastic.

Fig: 4.4 Flexible Tape meter:

- **Perambulating wheels:** Longer distances are measured with perambulating wheels. These wheels have a set diameter wheel and as you walk with the wheel, measurements are taken by a revolution counter and a diameter measurement for part revolutions of the measuring wheel.
- **A retractable Steel Tape Measure:** A retractable steel tape measure is used to measure dimensions.

It usually:

- ✓ comes in a plastic or metal case to make it durable
- ✓ has a clip on the side so that you can attach it to your belt
- ✓ has a locking device to hold the tape out in a fixed position.

The blade is generally marked in milli meters although some dual measurement tape measures are also available. These have milli meters on one half of the blade and inches on the other.

- **Retractable steel tape** measures come in a variety of lengths and widths. The most common are:

- ✓ 3 m, 5 m, 7 m and 8 m long
- ✓ 12 mm, 20 mm and 25 mm wide.

- **Extension rule:** The extension rule is a folding rule which includes a brass slide for making internal measurements. The slide can also be used as a depth gauge. The slide extends from the first strip of the rule. Steel tape (tape measure, push – pull steel tape, flexible rule, retractable steel tape measure, flex tapes).
  - ✓ The steel tape measure is an extendable steel strip coiled into a container.
  - ✓ The tape is spring loaded. So that as soon as it is released it will automatically return to the case.
  - ✓ Steel tapes are made from 2m to about 10m in length.
  - ✓ The shorter tapes are made with a curved, but rigid, cross section flexible enough to be rolled up. Long, flat tapes need support over their full length to avoid sagging.
  - ✓ Lack of support can cause reading errors.
  - ✓ There are many tapes made to suit special needs. The steel tape is made of flexible spring steel. Pocket steel tapes (push – pull steel tape) are shorter types of steel tapes.
  - ✓ The flexible rigid push pull steel tapes are usually contained in metal or plastic cases into which they wind themselves when a button is presses, or into which they can be easily pressed.
  - ✓ A hook is provided at one end to hook over the object being measured so one man can handle it. The graduations are printed on only one face of the tape.
  - ✓ A good tape will retract automatically and smoothly.

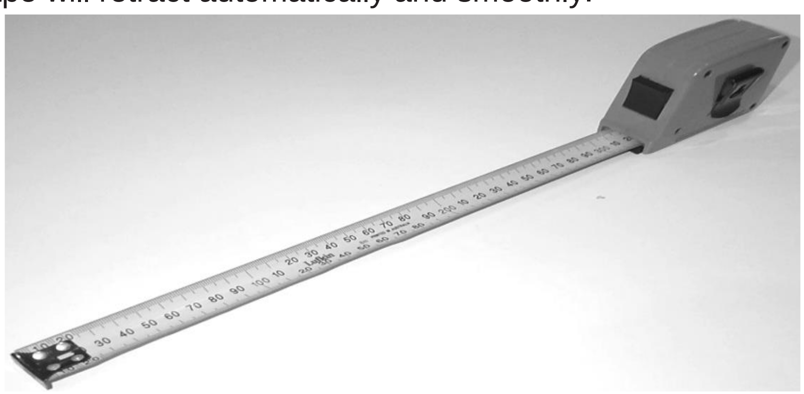


Figure 4.5 A steel tape mete

- **Pen or Pencil**
  - ✓ To record your measurements, you will need to use a pen or a pencil.
  - ✓ Make a rough sketch of what you are measuring and write the dimensions on this. Label your sketch so you know what it refers to.
- **. Calculator:** Used to work out complex calculations or just simple daily addition and subtraction. Calculators vary from simple to complex. Some even have more than one line of information. If you decide to use a calculator, we suggest that you use a

standard calculator rather than one in your clipboard or mobile phone. Standard calculators are easier to use. They are generally bigger, the numbers are easier to view and all the keys are available all the time!

Figure 4.6 Different types of calculator

- **Straight edge:** A straightedge is a wooden or plastic instrument used to draw straight lines. It is used to serve as a guide to check if the surface is flat. They are used in industries like the automotive industry and machining service. They are used to check the flatness of machine surfaces. It could be the side of a ruler, book, or a piece of paper. This can only be used to make straight lines but not to measure with. It has no gradations or markings which can help measure the length of a line. It does not have two parallel lines; it is just a straight line or edge.

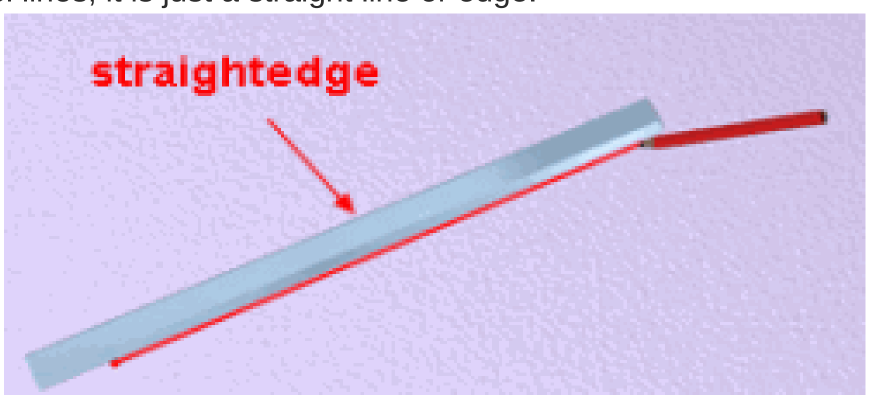


Figure 4.7: A straight Edge

.

Try square: The square refers to the tool's primary use of measuring the accuracy of a right angle (90 degrees); to try a surface is to check its straightness o correspondence to an adjoining surface. A traditional try square has a broad blade made of steel that is riveted to a wooden handle or 'stock'. The inside of the wooden stock usually has a brass strip fixed to it to reduce wear. Some blades also have graduations for measurement. Modern try squares may be all-metal, with stocks that are either die-cast or extruded.

Figure 4.8 Try square

- **Caliper**: These tools are comparators, used for transferring a dimension from one place to another.

Figure 4.9 Caliper

- **Slide caliper:** Slide caliper can be used for measuring outside and inside dimensions.

Figure 4.10 Slide Caliper

- **Vernier caliper:** Vernier calipers are used for more accurate measuring than can be achieved with a measuring rule or a slide caliper.

Figure 4.11 Vernier Caliper

- **Micrometer :** Micrometers are used for more accurate measuring than can be achieved with a measuring rule or a slide caliper.

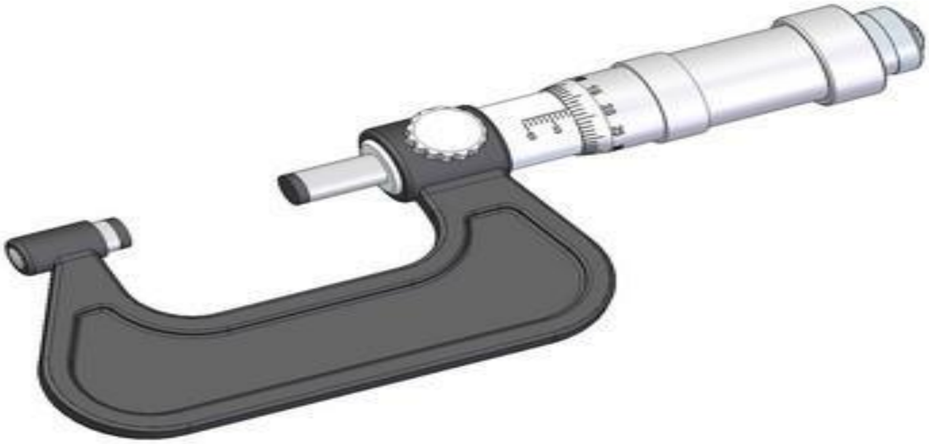


Figure 4.12 Micrometer

4.5. Selection of measuring tools and equipment's in electro mechanics works

The measuring instrument is the most important part of the measurement process and the selection of the instrument therefore has to be done carefully. If the selection is not correct, the result of the measurement may give a wrong indication, thereby leading to an incorrect decision.

- **Selection criteria:** The selection of measuring instruments depends on the measurement to be performed. Generally, three characteristics are considered; these are:
    - ✓ The range and magnitude of the parameter to be measured and the accuracy of the measurement (the instrument should have the range to cover effectively the range of the parameter).

- ✓ The resolution of the measuring instrument should be smaller than the minimum unit of measurement of the parameter.
- ✓ Lastly, and most importantly, the accuracy or uncertainty of the measuring instrument should comply with the accuracy requirement of the parameter to be

- **DIGITAL METERS** A digital voltmeter (DVM) is an instrument that displays a measured dc/ac voltage in discrete numerals, A decimal-point placement is included so that the exact value is evident. In some models, a plus or minus sign appears to the left of the numbers to indicate the polarity of the voltage being measured. The conventional meter with a pointer is an analog meter because its deflection corresponds directly to the measured quantity. Digital readout has several advantages over analog display: There are no observational errors such as parallax and estimation; there are fewer range scales; and it allows faster reading of numerical values, greater accuracy, and capability of feeding output directly to recorders for processing by digital computers
- **AMMETERS: -** An ammeter measures electric current. Its scale may be calibrated in amperes, mill amperes, or microamperes. To measure current, an ammeter is inserted in series with the circuit being tested. The addition of the ammeter increases the resistance of the circuit by an amount equal to the internal resistance of the meter RM.
- **VOLTMETERS: -** measures the voltage in the circuit or device and it is connected in parallel in the circuit. Voltmeter Loading Effect When a voltmeter is connected to a circuit, the voltmeter draws current from the circuit. This current produces a voltage drop across the resistance of the coil, which is subtracted from the voltage being measured. This reduction in voltage is called the loading effect.
- **OHMMETERS: -** An instrument to determine resistance is the ohmmeter. The ohmmeter consists of a battery, a meter movement calibrated to read ohms, and a resistor. Ro is a current-limiting resistance and includes the meter resistance RM. Ro is shown as an adjustable resistor for zeroing and for correcting the aging of the battery. R, is the unknown resistance to be measured. Zeroing is done by first short-circuiting the ohmmeter terminals and adjusting Ro to produce full-scale deflection. Thus, the ohmmeter can be used to test for continuity. This test should be conducted on the lowest ohms range. A break in the wire will give a reading of infinite resistance, indicating an open circuit and closed wire show same amount of resistance OR sound.
- **MULTIMETERS: -** is a single instrument capable of measuring voltage, resistance, and current. The volt-ohm-mili ammeter (VOM) is the most common multi meter.

One-meter movement is used to measure mill amperes, dc voltage, ac voltage, and ohms.

- **Wattmeter**; - is an instrument that measures dc power or real ac power. The wattmeter uses fixed coils to indicate current in the circuit, while the movable coil indicates voltage. Then the current in the fixed coils is proportional to I, while the current in the movable coil is proportional to V. The deflection of the pointer then is proportional to the VI product, which is power.
- **Watt hour Meter: -** When the power being dissipated in a load is calculated in terms of time, the amount of energy consumed by the load can be found. The unit commonly used for electric energy calculation is the kilowatt-hour (kWh). It is the product of kilowatts and hours. For example, 1 kWh = 1000W x 1 h = 200W X 5h = 1 W x 1OOOh = 500W x 2h the most common energy-measuring device is the watt hour meter. The speed of the rotating aluminum disk (rotor of an ac motor) is determined by the magnetic fields set up by the current and voltage coils. The greater the power passing through the meter, the faster the disk turns. The number of turns is a measure of the energy consumed by the load. The shaft on which the disk is mounted is geared to a group of indicators with clocklike faces. By reading the values on their faces at different times, you can determine how much energy passed through the meter during the interval between readings.

Self-Check 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I: <u>Say true and false for the following question below</u>

____1. A product data-sheet like any data-sheet, has a different data model per Category.

____ 2. Specification is an exact statement of the particular needs to be satisfied, or essential characteristics that a customer requires T

____3. **spec sheet** a document that summarizes the performance and other

characteristics of a product, machine, component. T

Part II. <u>Choose the best answer from the question below</u>

1. ____________is usually used for the commercial to describe the characteristics of an item or product.
   a. information C. Data sheet
   b. Product image D. logos

2. ____________is express the level of performance of the individual units
   b. **Technical specifications** **C. datasheets**
   c. **Performance specifications** **D. all**

3. ____________are written usually in a manner that enables both parties to measure the degree of conformance.
   a. Data sheet C. specification
   b. Description D. all

Answer Sheet

Name: ________________________ Date: ______________

Score = ___________

Rating:

Satisfactory rating: 3 and above **unsatisfactory rating: Below 3**

5.1. Introduction to Work Station of Electrical Hand Tools

The floor and interior of the operator's station/work station should be made of fire-resistant materials. Machines with an engine performance exceeding 30 kW should have a built-in fire extinguisher system or a location for installing a fire extinguisher that is easily reached by the operator. Also, your practical work shop tool preparation must be ready for any electrical work activates at any time.

5.2. SAFE WORK PRACTICES

A safe work environment is not enough to control all electric hazards. You must also work safely. Safe work practices help you control your risk of death from workplace hazards. If you are working on electrical circuits or with electrical tools and equipment, you need to use safe work practices.

- Before you begin a task, ask yourself:
- What could go wrong?
- Do I have the knowledge, tools, and experience to do this work safely?

All workers should be very familiar with the safety procedures for their jobs. You must know how to use specific controls that help keep you safe. You must also use good judgment and common sense.

5.3. Cleaning

- Clean the tools immediately after use.
- Wash the tools using water. A wire brush may be useful to loosen the soil stuck to the blades.
- Avoid the risk of spreading pathogens while the tools are being cleaned.
- Coat the blades with light oil like WD-40 on areas prone to rust.

5.4. **Lubrication** is the process or technique employed to reduce friction between, and wear of one or both, surfaces in proximity and moving relative to each other, by interposing a substance called a lubricant in between them. The lubricant can be a solid, (e.g. Molybdenum disulfide MoS_2) a solid/liquid dispersion, a liquid such as oil or water, a liquid-liquid dispersion (a grease) or a gas.

✓ With fluid lubricants the applied load is either carried by pressure generated within the liquid due to the frictional viscous resistance to motion of the lubricating fluid between the surfaces, or by the liquid being pumped under pressure between the surfaces.

✓ Lubrication can also describe the phenomenon where reduction of friction occurs unintentionally, which can be hazardous such as hydroplaning on a road.

5.5. Storage

Store tools in a dry, sheltered environment. Place tools on a rack for easy safety and easy access.

Place similar tools close together so that workers can see easily the available tools.

5.6. Storing tools safely in appropriate locations in accordance with manufacturers

- **Tools Habits**

"A place for everything and everything in its place" is just common sense. You cannot do an efficient, fast repair job if you have to stop and look around for each tool that you need. The following rules, if applied, will make your job easier.

✓ **Keep Each Tool in Its Proper Storage Place**. A tool is useless if you cannot find it. If you return each tool to its proper place, you will know where it is when you need it.

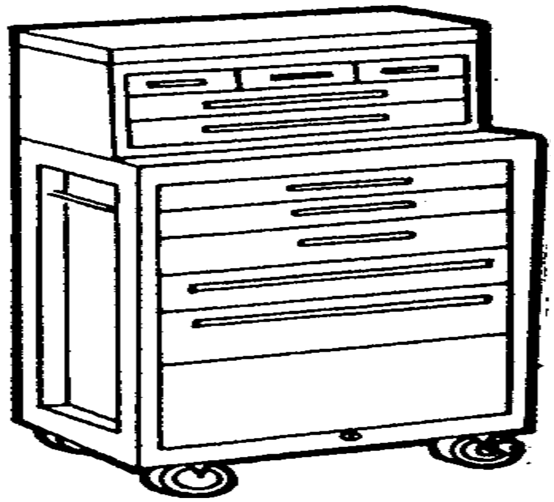


Fig. 4.1. Tools storage

✓ **Keep Your Tools in Good Condition**. Keep them free of rust, nicks, burrs, and breaks.

✓ **Keep Your Tool Set complete.** If you are issued a tool box, each tool should be placed in it when not in use. If possible, the box should be *locked* and stored in a designated area. Keep an inventory list in the box and check it after each job. This will help you to keep track of your tools.

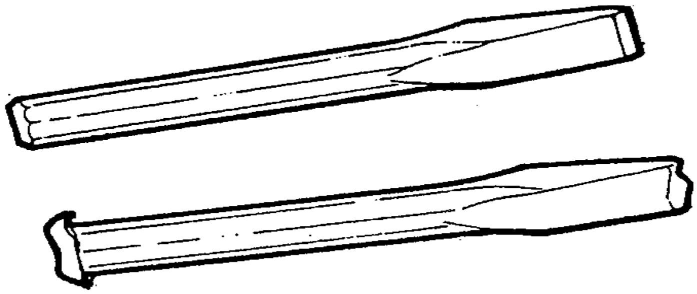


Fig. 5.2. Chisel

- **Use Each Tool Only on The Job for Which It Was Designed.** If you use the wrong tool to make an adjustment, the result will probably be unsatisfactory. For example, if you use a socket wrench that is too big, you will round off the corners of the wrench or nut. If this rounded wrench or nut is not replaced immediately, the safety of your equipment may be endangered in an emergency.

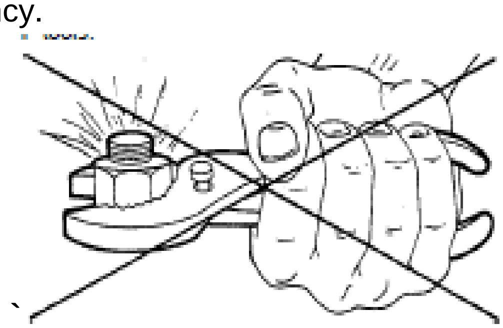


Fig.5.3. unpropre use of tools

- **Keep Your Tools Within Easy Reach and Where They Cannot Fall on The Floor or On Machinery**. Avoid placing tools anywhere above machinery or electrical apparatus. Serious damage will result if the tool falls into the machinery after the equipment is turned on or running.

NOTE: Return broken tools to section chief.

- **Never Use Damaged Tools**. Notify your supervisor of broken or damaged tools. A battered screwdriver may slip and spoil the screw slot or cause painful injury to the user. A gage strained out of shape will result in inaccurate measurements.

5.7. Storage Items

- **Toolboxes**

Steel toolboxes are most popular. Their prices vary according to gauge of steel used, number of trays and whether the box is reinforced in the corners.

Some precision tool users use hardwood chests because the wood absorbs rust-producing condensation. Carpenters' toolboxes are specially designed so carpenters can carry hand

saws and framing squares in the same box with other tools. The word "carpenter" differentiates this box from a regular toolbox because of the extra tools it will carry.
Plastic toolboxes are available in a number of styles. Some are suited for light-duty use, while others are comparable to steel in quality.
The highest quality plastic boxes are constructed of polypropylene, and some models can hold up to 75 lbs. of tools. The high-quality plastic boxes feature interlocking pinned hinges, tongue-in-groove closure and positive locking latches, as well as padlock eyes and lift-out trays.

- **Tool Chests**

Utility chests store parts, screws, nuts, bolts and other small pieces. These chests are made of either plastic or steel with removable plastic dividers.

- **Tool Caddies**

Plastic revolving tool caddies hold tools and items such as nails, bolts, screws, glue and wire in tiers of circular trays.
The caddies are made of a high-impact plastic and feature a ball bearing base plate, allowing the unit to revolve easily.

- **Modular Workshops**

Modular, mobile workshops are increasing in popularity, as users like their adaptability and functionality. Some models feature adjustable leveling feet, adjustable height, detachable casters, latching doors, drawers, hooks for hanging tools, dust collection ports, quick-change tool set-up, lock-down hardware and corner tops. They can hold large and small tools, and can be designed to serve as a shop bench, router station or clamping station.

- **How to Choose and Use Tool Boxes**

The "Types and Uses" section provides you with a list of some of the types of tool boxes. These pages should help you select the right tool box to do the job.

Fig.5.4. tools box

5.8. Types and Uses

Tool boxes are used for storing tools. They are usually made of steel, but wood and plastics are also used. Portable tool boxes are used for carrying and storing a variety of hand tools. Both special and common tools, such as mechanic's, electrician, and carpentry tools can be found in tool boxes. Chest-type tool boxes generally contain larger tools, such as specialized automotive tools or machinist's tools, requiring a more permanent location. Some larger tool boxes are mounted on wheels so they can be moved easily from place to place. Tool bags are usually made of canvas. Like the boxes, they are available in a variety of sizes and serve similar functions.

Examples of tool boxes are illustrated below.

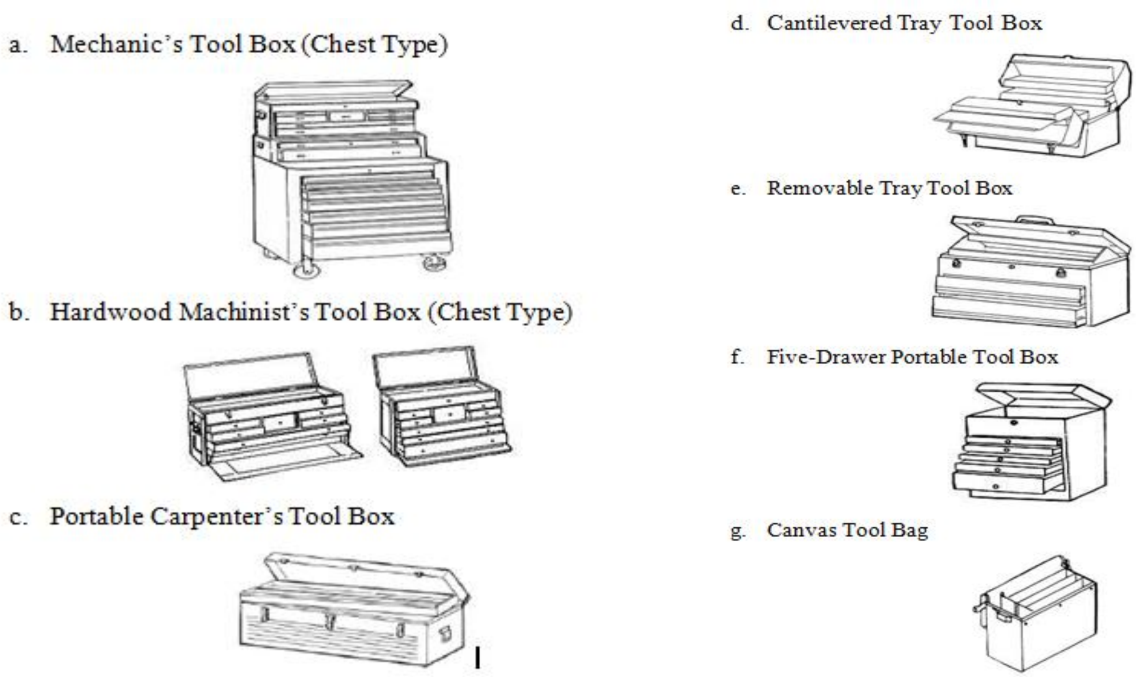


Fig. 5.5. Different tools box

Self-Check 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part Ⅰ: Say true and false for the following question below

____________1. A safe work environment is enough to control all electric hazards.

____________2. Lubrication is the process or technique employed to reduce friction .

____________3. Portable tool boxes are not used for carrying and storing a variety of hand tools

Part Ⅱ . Choose the best answer from the question below

1. Which one of the following used for storing tools?
   - **A. Tool box**
   - **B. Lubrication**
   - **C. Cleaning**
   - **D. none**

Answer Sheet

Name: _________________________ Date___________

1.

Instruction Sheet 2	Learning Guide 40:Obtain Measuring Instrument

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Selecting appropriate measuring instrument
- Obtaining accurate measurement
- Performing calculation to complete work tasks.
- Using calculation to complete workplace tasks.
- Checking and correcting numerical computation for accuracy
- Reading instruments to the limit accuracy of the tool.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to

- Select appropriate ***measuring instrument*** to achieve required outcome
- Obtain accurate measurements are for job.
- Perform ***calculation*** needed to complete work tasks using the four basic process of addition (+), subtraction (-), multiplication (x), and division (/)
- Use calculation involving fractions, percentages and mixed numbers to complete workplace tasks.
- Check and correct numerical computation for accuracy
- Read Instruments to the limit of accuracy of the tool.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 14.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the Self-check 1,
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).

6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2”
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the “Information Sheets 3 and 4”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3”
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation, proceed to “Operation Sheet 1” However, if your rating is unsatisfactory, see your teacher for further instructions or go back to for each Learning Ac

Information Sheet-1	Selecting appropriate measuring instrument

1.1 Introduction

A measuring instrument is a device for measuring a physical quantity. In the physical sciences, quality assurance, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events. Established standard objects and events are used as units, and the process of measurement gives a number relating the item under study and the referenced unit of measurement. Measuring instruments, and formal test methods which define the instrument's use, are the means by which these relations of numbers are obtained. All measuring instruments are subject to varying degrees of instrument error and measurement uncertainty. Scientists, engineers and other humans use a vast range of instruments to perform their measurements. These instruments may range from simple objects such as rulers and stopwatches to electron microscopes and particle accelerators. Virtual instrumentation is widely used in the development of modern measuring instruments.

1.2 Measuring instrument selection criteria

One of the tasks at planning of quality inspection is selection of measuring instruments. The measuring instruments are the most important part of the measuring process so their selection have to be done carefully. The selection of measuring instruments is a complex task, which depend on the size, the character and the value of measured magnitude. The purpose of this paper is to analyze the existing methods for selection of measuring equipment. In the paper are presented the advantages and disadvantages of existing methods and recommendation for their implementation, according to the metrological tasks given. There are results obtained, using the Measurement System Analysis (MSA), for: selection of the correct measuring instrument and method; assessment the capabilities of measuring instruments; assessment of the procedures and operators; assessment of any measuring interactions, calculating the uncertainty of measuring of individual measuring instrument and/or measuring systems.

- **The selection of measuring instruments** depends on the measurement to be Performed. Generally, three characteristics are considered; these are:
  - ✓ The range and magnitude of the parameter to be measured and the accuracy of the measurement (the instrument should have the range to cover effectively the range of the parameter).
  - ✓ The resolution of the measuring instrument should be smaller than the minimum

- ✓ unit of measurement of the parameter.
- ✓ Lastly, and most importantly, the accuracy or uncertainty of the measuring instrument should comply with the accuracy requirement of the parameter to be measured.

Table. 2.1. Accuracy of measurement

Parameter to be measured	Accuracy of measurement
100° ± 10°C	± 3°C
100° ± 1ºC	± 0.3°C

In order to select the correct measuring instrument, the implications of instrument accuracy on the measurement data and the effect it has on decisions taken based on the data must be clearly understood. If the accuracy of a measuring instrument is ± 1, this means that the value displayed on the instrument would be considered the correct value so long as the actual value of the measurement is within ± 1 of the actual value. In other words, if 10 is the reading displayed on a measuring instrument while making a measurement and if ± 1 is the accuracy of that instrument, then the actual value could be anywhere between 9and 11, including either 9 or 11. Thus, the expanded value of the measurement can be considered as 11. Instead of direct algebraic addition, however, a better projectionist that instead of 11, the expanded value is $\sqrt{10^2+1^2}$ = (101) = 10.05. Thus, the original value of 10 has now been expanded to 10.05. This is based on the statistical theory of root sum squares. So now, instead of 11, the original value becomes 10.05 based on the accuracy of the measuring instrument.

Selection criteria, as mentioned above, should generally be followed when procuring new instruments. However, in many cases the measuring instruments are already available. In such situations, action as described below should be taken.

- First, the parameter being measured should be examined to check whether the tolerance and the accuracy have been stated. Next, the measuring instrument should be checked to see whether the range and the resolution are appropriate for the measurement. Lastly, the accuracy of the instrument should be checked to see whether
- it satisfies the specified requirement. In cases where the accuracy of the measurement is not specified, the instrument’s accuracy should be examined to see if it is better than one third of the tolerance. If it is, then the instrument selection was appropriate.

- If, however, the measuring instrument's accuracy is more than one third of the tolerance of the parameter, then either of the following actions should be taken:
  - ✓ Replace the instrument with an appropriate one, if the present system of measurement is affecting the quality of the product resulting in rejection or rework at the subsequent stage of production;
  - ✓ Review the specified tolerance if the existing measurement system does not affect the product quality. This means that perhaps the close tolerance specified is not needed and hence the tolerance could be increased to accommodate the accuracy of the instrument.
- For measurement data to be reliable, measurement should be:
  - ✓ Accurate
  - ✓ Precise
  - ✓ Reproducible

Handling and storage of measuring instruments is very important for the measurement process. If handling and storage of such instruments is not appropriate, even a robust one may malfunction or may give erroneous output. To ensure proper handling and storage, a system approach is the most suitable.

Self-Check1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I : Say true and false for the following question below

__________ 1. The range and magnitude of the parameter to be measured.

__________ 2. Handling and storage of measuring instruments is not very important for the measurement process.

Part II. Choose the best answer from the question below

1. Which one of the following Measuring instruments?
   A. Multi range meter
   B. Screw driver
   C. Electrical knife
   D. Side cutter
2. Which one of the following characteristics of Measuring instrument**?**
   A. Range and magnitude
   B. Resolution
   C. Accuracy
   D. All
3. Which one of the following is **selection** criteria for measuring instrument?
   A. Resolution
   B. Accuracy
   C. Precise
   D. All

Answer Sheet

Name: ____________________________ Date: _______________

Score = ___________

Rating:

Satisfactory rating: above 2 **unsatisfactory rating: Below 2**

Information Sheet-2	Obtaining accurate measurement

2.1. Measurements and calculation

RATIO AND PROPORTION

- ✓ **RATIO: -**is a comparison of two or more quantities. The ratio of two quantities is the quotient of two quantities that tells the numerical relationship of the two quantities usually written as fractions. Ratios are expressed by the symbol (:) placed between the two numbers being compared or in the forms of fractions.Eg.2/4,2:4,1:2. This means If the total quantity (student) is 90,30students are girls and 60 students are boys.

Example

1. State the ratio between 40cm and 2m.
   2mx100=200cm
   40cm/200cm=1/5cmor 1:5

Calculate the followings

1. Two speeds are in the ratio 2:5 if the first speed is 60km/hr, what is the second speed? IF360 birr is divided among three people in the ratio of 3:4:5, find the share of each people. The height of chaltu to chala is in the ratio of 5:7. If chala's height is 1.75m,

what is chaltu's height?

- **PROPORTION: -**is an equality of two quantities or ratios. When two ratios are equal the four terms taken in order are called proportional's and the ratios are said to be in proportion.eg a/b: c/d, ratio a:b is proportional to c: that means ad(extremes)=bc (means).

Example.

1.Find the unknown terms in each of the following proportions.

a).5:15=Y:6 b).2: Z=4:12

15xY=5x6 Zx4=2x12

Y=5x6/15=2, Y=2 Z= 2x12/4=6, Z=6

EX. Are the following numbers taken in order of proportion?

a)3,6,7,12 b).2,5,8.20 c)6,12,12.24

- **DIRECT PROPORTIONALITY**

Y is said to be directly proportional to X (Y∞X) if ther is a constant k, such that Y=kX. k is called the constant of proportionality.

EXAMPLE

If the connected load/resistance/ in the circuit is constant 5o ohm with 1A , see the following table

Current in amps (X)	1A	2A	3A	4A
Voltage in volts (Y)	50v	100v	150v	200v

Y is directly proportional to X because as X increases Y also increase as a factor of 50 x. Observe the table carefully that 50=50/1=100/2=150/3=200/4 is the constant of proportionality is k=50 ohm.

- **INVERSE PROPORTIONALITY**

Y is said to be inversely proportional to X (Y ∞ 1/X) if there is a constant k such that Y=K.1/X or Y.X=K

Compare the proportionality of current and resistance in a simple dc circuit of constant voltage 200v per one ampere

Current in Amps (X)	1A	2A	3A	4A
Resistance in ohms(Y)	200	100	66.67	50

Remember that as the current (X) increase, the resistance of the circuit(Y) decrease but Y.X is constant=200

- **PERCENT**

The word percent means "for every hundred". When we speak of a certain percent of something, we mean that it is that portion of 100 units. Percent is designated by %.

For example, 20% is read as 20 percent, it means 20 out of every hundred and is equivalent to 20/100.

To express a given decimal fraction or common fraction as a percent, we multiply the decimal fractions or the common fraction by 100/100.

Eg. a).0.05=0.05 x 100/100=5/100=5%

b). ½ =1/2 x100/100=50/100=50%

To express a percent as a common fraction, omit the percent sign and write the percent as the numerator of a fraction whose denominator is 100 then reduce this fraction to its lowest term.

Example

a).35%=35/100=7/20=0.35

- **AREA AND VOLUME**
  - ✓ Area is the space/surface of an object

1. The area of a square $A = b^2$

1.The area of a rectangle A=bh (base x height)

2. The area of a triangle A=1/2bh (base x height)

3. The area of a parallelogram A=bh (base x height)

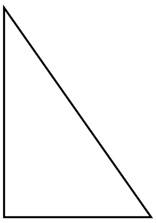
4. The area of a circle $A=\prod r^2$ or $A=\prod d^2/4$

5. Circumference of a circle $C=2\prod r$ or $c=\prod d$

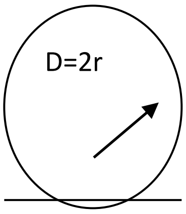
Example.

B=3m

a H=2m h=4m



b= 3m



A=B.  A=1/2bh=1/2.3.4=6m^2 $A=\prod r2=3.14x2^2=12.56m^2$

The diameter of the circle is 2r ie d=2x2=4

Therefore, the circumference of the circle $C=\prod d=3.14x4=12.56$

The size any wire can be known by measuring the diameter of the wire using micrometer or

A wire with a core diameter of 1.38 mm would have a cross-sectional area of:

$$A = \frac{d \times d \times 3.14}{4}$$

$$A = \frac{1.38 \times 1.38 \times 3.14}{4}$$

A = 1.5 square mm

A = d x d x 0.785

A = 1.38 x 1.38 x 0.785

A = 1.5 square mm

Or a wire with a core diameter of 2.76 mm would have a cross-sectional area of:

$$A = \frac{d \times d \times 3.14}{4}$$

$$A = \frac{2.76 \times 2.76 \times 3.14}{4}$$

A = 6 square mm

A = d x d x 0.785

A = 2.76 x 2.76 x 0.785

A = 6 square mm

venire caliper.

- **VOLUME**

The volume of prisms with length (L), width (w) and height (h) is the products of length, width and height (V=l.w.h), V=AH (A=l.w)

Eg. Find the volume of a rectangular prism of 2cm length,3cm width and 5cm height?

V= l.w.h=2x3x5=30cm^3

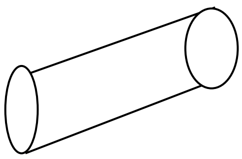
The volume of a cylinder is also calculated in the same way as prisms. Multiply the area of the base by the altitude/height/.

Shape	**Volume formula**	**Variables**
Cube	a^3	*a* = length of any side (or edge)
Cylinder	$\pi r^2 h$	*r* = radius of circular face, *h* = height
Prism	$B \cdot h$	*B* = area of the base, *h* = height
Rectangular prism	$l \cdot w \cdot h$	l = length, w = width, h = height

Sphere	$\frac{4}{3}\pi r^3$	*r* =r radius of sphere which is the integral of the surface area of a sphere
Ellipsoid	$\frac{4}{3}\pi abc$	*a*, *b*, *c* = semi-axes of ellipsoid
Pyramid	$\frac{1}{3}Bh$	*B* = area of the base, *h* = height of pyramid
Cone	$\frac{1}{3}\pi r^2 h$	*r* = radius of circle at base, *h* = distance from base to tip

Eg. Find the volume of a cylinder with 6cm diameter and 3.5cm high.

V=A.h



$V=\prod r^{2.}$ h

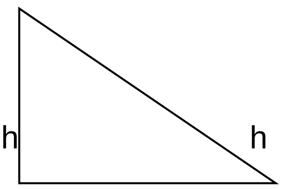
r=d/2=6/2=3cm

$V=22/7 \times (3cm)^2 \times 7/2cm=11 \times 9\ cm^3 = 99cm^3$

- **TRIGONOMETRIC FUNCTIONS**

The three trigonometry functions are SINE, COSINE AND TANGENT. The Sine function is the set of ordered pairs Y axis and p coordinate point the cosine function is the set of ordered pairs X axis and p coordinate point The Tangent function is the set of ordered pairs Y/X axis and p coordinate point.

Eg.



$X = \sqrt{3}/2h$ 30^{o}

Sine=1/2 or y/h

Cosine=$\sqrt{3}/2$ or x/h

Tan=sine/cosine=1/2 / $\sqrt{3}/2=\sqrt{3}/3$

Study the value of sine and cosine from numerical table at various degrees.

Eg. Sine 30^{o}=0.5 or 1/2, cosine 30^{o}=$\sqrt{3}/2$ or 0.866, tan30o=$\sqrt{3}/3$=0.577

Self-Check 2	Written Test

Direction: choose the best answer for all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

Part. I Choose the best answer from the question below

1. The area of a square below is 18 square units. What is the perimeter of the rectangle?
   A. 34 units
   B. 36 units
   C. 20 units
   D. 22 units
2. Which one of the following is the SI unit of length? (2Points)
   A. Kilo gram
   B. Meter
   C. Second
   D. Square meter

Part II. Match

Column A	**Column B**
_______1. Volume.	A. equality of two quantities or ratios.
_______2. Area.	B. comparison of two or more quantities.
_______3. Proportional .	C. surface of an object
_______4. Ratio	D. meter cube

Satisfactory rating: 3 and above **unsatisfactory rating: Below 3**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information Sheet-3	Performing **calculation** to complete work tasks using

3.1 The four basic mathematical operation

- **CALCULATION:** Is a deliberate process that transforms one or more inputs into one or more results, with variable change. The term is used in a variety of senses, from the very definite arithmetical calculation of using an algorithm, to the vague heuristics of calculating a strategy in a competition, or calculating the chance of a successful relationship b/n two people. To calculate means to ascertain by computing.
    - ✓ Area,
    - ✓ Volume,
    - ✓ Triangle
    - ✓ Perimeter
    - ✓ Circle and
    - ✓ Circumference)

The four basic mathematical operations: Addition, subtraction, multiplication, and division have application even in the most advanced mathematical theories. Thus, mastering them is one of the keys to progressing in an understanding of math and, specifically, of algebra.

- **Addition, Subtraction, Division and Multiplication**
- **Addition and subtraction**: are two complementary operations. We can actually define subtraction in terms of addition. Addition is simply the combination of distinct sets of like entities (and we must stress the word like). Thus, if we add one set of four squares to another set of five squares, we get a total of nine squares or simply 4+5=9.

If two numbers are added, it does not matter in which order they are added. (Forexample,5+3=8 and 3+5=8, or 5+3=3+5) this statement generalized and accepted as being correct for all Possible combinations of numbers being added, is called **the commutative law for addition.** It states that the sum of two numbers is the same, regardless of the order in which they are added. We make no attempt to prove this law in general, but accept that it is true.

In the same way, we have **the associative law for addition**, which states that the sum of three or more numbers is the same, regardless of the way in which they are grouped for addition.

For-example, 3 + (5 + 6) = (3 + 5) + 6.

- **Subtraction**: is the opposite of addition. Instead of adding two quantities (numbers), we are removing one from another. Thus, if we have nine squares and take away (subtract) five, we are left with four squares. Using just the numbers, where the minus sign (-) represents the subtraction operation, 9-5=4

Here, 9 and 5 are the terms of the operation, and 4 is the difference. Unlike addition, ***subtraction is not***

commutative. That is to say, 9-5 and 5-9 are not the same.

- **Multiplication:** The two numbers to be multiplied are called factors, and the result is called the product. The laws just stated for addition are also true for multiplication.

Therefore, the product of two numbers is the same, regardless of the order in which they are multiplied, and the product of three or more numbers is the same, regardless of the way in which they are grouped for multiplication.

For example, 2 * 5 = 5 * 2, and 5 * (4 * 2) = (5 * 4) * 2.

Another very important law is the distributive law. It states that the product of one number and the sum of two or more other numbers is equal to the sum of the products of the first number and each of the other numbers of the sum.

For example, 5(4+2) =5*4+5*2

- **Division**: is the inverse of multiplication. The number being divided is called dividend, the number by which it is divided is called the divisor, and the result is called quotient. Unlike multiplication, ***division is not commutative.***
- **Fundamental laws of algebra**
    - Commutative law of addition: a + b =b + a
    - Associative law of addition: a + (b + c) = (a + b) + c
    - Commutative law of multiplication: a (b*c) =(a*b) c
    - Associative law of multiplication: a (b*c) = (a*b) c
    - Distributive law: a (b + c) = a*b + a*c

3.2 OPERATION ON POSITIVE AND NEGATIVE NUMBERS

When using the basic operations (addition, subtraction, multiplication, division) on positive and negative numbers, we determine the result to be either positive or negative according to the following rules.

I. ***Addition of two numbers of the same sign***.

- Add their absolute values and assign the sum their common sign.

EXAMPLE 1 Adding numbers of the same sign

(a) $2 + 6 = 8$ — the sum of two positive numbers is positive

(b) $-2 + (-6) = -(2 + 6) = -8$ — the sum of two negative numbers is negative

✓ The negative number -6 is placed in parentheses since it is also preceded by a plus sign showing addition. It is not necessary to place the -2 in parentheses.

II. ***Addition of two numbers of different signs***.

- Subtract the number of smaller absolute value from the number of larger absolute value and assign to the result the sign of the number of larger absolute value.

EXAMPLE 2 Adding numbers of different signs

(a) $2 + (-6) = -(6 - 2) = -4$ — the negative 6 has the larger absolute value

(b) $-6 + 2 = -(6 - 2) = -4$

(c) $6 + (-2) = 6 - 2 = 4$ — the positive 6 has the larger absolute value

(d) $-2 + 6 = 6 - 2 = 4$

(the subtraction of absolute values)

III. ***Subtraction of one number from another.***

- Change the sign of the number being subtracted and change the subtraction to addition. Perform the addition.

EXAMPLE 3 Subtracting positive and negative numbers

(a) $2 - 6 = 2 + (-6) = -(6 - 2) = -4$

Note that after changing the subtraction to addition, and changing the sign of 6 to make it -6, we have precisely the same illustration as Example 2(a).

(b) $-2 - 6 = -2 + (-6) = -(2 + 6) = -8$

Note that after changing the subtraction to addition, and changing the sign of 6 to make it -6, we have precisely the same illustration as Example 1(b).

(c) $-a - (-a) = -a + a = 0$

This shows that subtracting a number from itself results in zero, even if the number is negative. Therefore, *subtracting a negative number is equivalent to adding a positive number of the same absolute value.*

IV. **Multiplication and division of two numbers**

- The product (or quotient) of two numbers of the same sign is positive. The product (or quotient) of two numbers of different signs is negative.

EXAMPLE 4 Multiplying and dividing positive and negative numbers

(a) $3(12) = 3 \times 12 = 36$ $\quad \frac{12}{3} = 4$ — result is positive if both numbers are positive

(b) $-3(-12) = 3 \times 12 = 36$ $\quad \frac{-12}{-3} = 4$ — result is positive if both numbers are negative

(c) $3(-12) = -(3 \times 12) = -36$ $\quad \frac{-12}{3} = -\frac{12}{3} = -4$ — result is negative if one number is positive and the other is negative

(d) $-3(12) = -(3 \times 12) = -36$ $\quad \frac{12}{-3} = -\frac{12}{3} = -4$

3.3 ORDER OF OPERATIONS

Often, how we are to combine numbers is clear by grouping the numbers using symbols such as parentheses (), the bar, ____, between the numerator and denominator of a fraction, and vertical lines for absolute value. Otherwise, for an expression in which there are several operations, we use the following order of operations.

ORDER OF OPERATIONS

1. *Operations within specific groupings are done first.*
2. *Perform multiplications and divisions (from left to right).*
3. *Then perform additions and subtractions (from left to right).*

EXAMPLE 5 Order of operations

(a) $20 \div (2 + 3)$ is evaluated by first adding $2 + 3$ and then dividing. The grouping of $2 + 3$ is clearly shown by the parentheses. Therefore, $20 \div (2 + 3) = 20 \div 5 = 4$.

(b) $20 \div 2 + 3$ is evaluated by first dividing 20 by 2 and then adding. No specific grouping is shown, and therefore the division is done before the addition. This means $20 \div 2 + 3 = 10 + 3 = 13$.

(c) $16 - 2 \times 3$ is evaluated by ***first multiplying*** 2 ***by*** 3 and then subtracting. We *do* **not** *first subtract* 2 *from* 16. Therefore, $16 - 2 \times 3 = 16 - 6 = 10$.

(d) $16 \div 2 \times 4$ is evaluated by first dividing 16 by 2 and then multiplying. From left to right, the division occurs first. Therefore, $16 \div 2 \times 4 = 8 \times 4 = 32$.

(e) $|3 - 5| - |-3 - 6|$ is evaluated by first performing the subtractions within the absolute value vertical bars, then evaluating the absolute values, and then subtracting. This means that $|3 - 5| - |-3 - 6| = |-2| - |-9| = 2 - 9 = -7$.

When evaluating expressions, it is generally more convenient to change the operations and numbers so that the result is found by the addition and subtraction of positive numbers. When this is done, we must remember that

$$a + (-b) = a - b$$
$$a - (-b) = a + b$$

EXAMPLE 6 Evaluating numerical expressions

(a) $7 + (-3) - 6 = 7 - 3 - 6 = 4 - 6 = -2$

(b) $\frac{18}{-6} + 5 - (-2)(3) = -3 + 5 - (-6) = 2 + 6 = 8$

(c) $\frac{|3 - 15|}{-2} - \frac{8}{4 - 6} = \frac{12}{-2} - \frac{8}{-2} = -6 - (-4) = -6 + 4 = -2$

(d) $\frac{-12}{2 - 8} + \frac{5 - 1}{2(-1)} = \frac{-12}{-6} + \frac{4}{-2} = 2 + (-2) = 2 - 2 = 0$

In illustration (b), we see that the division and multiplication were done before the addition and subtraction. In (c) and (d), we see that the groupings were evaluated first. Then we did the divisions, and finally the subtraction and addition.

EXAMPLE 7 Evaluating in an application

A 1500-kg van going at 40 km/h ran head-on into a 1000-kg car going at 20 km/h. An insurance investigator determined the velocity of the vehicles immediately after the collision from the following calculation. See Fig. 1.5.

$$\frac{1500(40) + (1000)(-20)}{1500 + 1000} = \frac{60\,000 + (-20\,000)}{1500 + 1000} = \frac{60\,000 - 20\,000}{2500}$$
$$= \frac{40\,000}{2500} = 16 \text{ km/h}$$

The numerator and denominator must be evaluated before the division is performed. The multiplication in the numerator are performed first, followed by the addition in the denominator.

3.4 OPERATION WITH ZERO

Since operations with zero tend to cause some difficulty, we will show them here.

If a is a real number, the operations of addition, subtraction, multiplication, and division with zero are as follows:

$$a + 0 = a$$

$$a - 0 = a \qquad 0 - a = -a$$

$$a \times 0 = 0$$

$$0 \div a = \frac{0}{a} = 0 \qquad (\text{if } a \neq 0)$$ ($\neq$ means "is not equal to")

EXAMPLE 8 Operations with zero

(a) $5 + 0 = 5$ (b) $-6 - 0 = -6$ (c) $0 - 4 = -4$

(d) $\frac{0}{6} = 0$ (e) $\frac{0}{-3} = 0$ (f) $\frac{5 \times 0}{7} = \frac{0}{7} = 0$

Note that there is no result defined for division by zero. To understand the reason for this, consider the results for 6/2 and 6/0.

$$\frac{6}{2} = 3 \quad \text{since} \quad 2 \times 3 = 6$$

If $\frac{6}{0} = b$, then $0 \times b = 6$. This cannot be true because $0 \times b = 0$ for any value of b. Thus,

division by zero is undefined

(The special case of $\frac{0}{0}$ is termed *indeterminate*. If $\frac{0}{0} = b$, then $0 = 0 \times b$, which is true for any value of b. Therefore, no specific value of b can be determined.)

EXAMPLE 9 Division by zero is undefined

$\frac{2}{5} \div 0$ is undefined $\qquad \frac{8}{0}$ is undefined $\qquad \frac{7 \times 0}{0 \times 6}$ is indeterminate

The operations with zero will not cause any difficulty if we remember to

never divide by zero

Division by zero is the only undefined basic operation. All the other operations with zero may be performed as for any other number.

Self-Check 3	Written Test

- *Directions:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

Operation Sheet 1	Performing Calculations

QUALITY CRITERIA: The Mathematical operations should be performed to show the characteristics of the operations

PROCEDURE:

1. Arrange the provided paper, pen and if needed calculator, to perform calculation.
2. Add four consecutive numbers b/n 10 & 100 and record the answer.
3. Re-arrange their order and add them. Compare the result with that found instep 1.
4. Subtract the larger number from the smaller number and record their difference.
5. Subtract the smaller number from the larger number and record the difference.
6. Compare the result found in step 4 with that found in step 5.
7. Multiply three consecutive numbers b/n 10 & 20 and record their product.
8. Divide the larger number to the smaller number and record the quotient.
9. Write three different mixed fractions and convert them to percentage respectively.
10. Convert the result of step 9 to mixed fraction showing each step neatly.

PRECAUTIONS: Avoid interchanging positive numbers and negative numbers while performing the calculation.

4.1 Calculation in fraction, percentage and mixed number

Converting a mixed fraction into percentage:

Firstly, convert mixed fraction into improper fraction. (Mixed Fraction to Improper Fraction) then, multiply improper fraction by 100. Some example regarding to the Conversion of Mixed Fraction into Percentage are as follows:

Example 1: Convert a given mixed fractions 1 2/10 into percentage.

Answer = The procedure is: -

- ✓ Firstly, convert mixed fraction (1 2/10) into Improper Fraction and we get: = 1 2/10 = 12/10
- ✓ Now, Multiply the improper fraction (i.e. 12/10) by 100 and we get: = 12/10 × 100
- ✓ Multiply numerator of improper fraction (i.e. 12) by multiplier (i.e. 100) and denominator remains the same and we get: = 12×100/10 = 1200/10
- ✓ Divide numerator by denominator, and we get the required percentage: = 120 %

Example 2: Convert a given mixed fractions 2 3/5 into percentage.

Answer = The procedure is: -

- ✓ Firstly, convert Mixed Fraction (2 3/5) into Improper Fraction and we get: = 2 3/5 = 13/5
- ✓ Now, Multiply the improper fraction (i.e. 13/5) by 100 and we get: = 13/5 × 100
- ✓ Multiply numerator of improper fraction (i.e. 13) by multiplier (i.e. 100) and denominator remains the same and we get: = 13×100/5 = 1300/5
- ✓ Divide numerator by denominator, and we get the required percentage: = 260 %

- **Converting Percentage in to fractions**

To convert a percent to a fraction, follow these steps:

- ✓ Step 1: Write down the percent divided by 100 like this: percent/100
- ✓ Step 2: If the percent is not a whole number, then multiply both top and bottom by 10 for every number after the decimal point. (For example, if there is one number after the decimal, then use 10, if there are two then use 100, etc.)
- ✓ Step 3: Simplify (or reduce) the fraction

Example1: Convert 11% to a fraction

- ✓ Step 1: Write down: 11/100
- ✓ Step 2: The percent is a whole number, go straight to step 3.
- ✓ Step 3: The fraction cannot be simplified further.

- ✓ **Answer = 11/100**

Example2: Convert 75% to a fraction

- ✓ Step 1: Write down: 75/100
- ✓ Step 2: The percent is a whole number, go straight to step 3.
- ✓ Step 3: Simplify the fraction (this took me two steps; you may be able to do it one!):

4.2 Calculating perimeter, area and volume of a shape.

Calculating perimeter of a shape.

The perimeter of a shape is the sum of the lengths of its sides. Since the two lengths (l) are equal to each other and the two widths (w) are equal to each other in a rectangle, the formula for perimeter, P, of a rectangle is:

$P = 2(l + w)$ or $P = 2l + 2w$

The perimeter of a shape is defined as the distance around the shape. Since we usually discuss the perimeter of polygons (closed plane figures whose sides are straight line segment), we are able to calculate perimeter by just adding up the lengths of each of the sides.

- **The perimeter of a circle**

When we talk about the perimeter of a circle, we call it by the special name of circumference. Since we don't have straight sides to add up for the circumference (perimeter) of a circle, we have a formula for calculating this.

- **Calculating Area of a shape.**

The area of a shape is defined as the number of square units that cover a closed figure. For most of the shape that we will be dealing with there is a formula for calculating the area. In some cases, our shapes will be made up of more than a single shape. In calculating the area of such shapes, we can just add the area of each of the single shapes together.

- **Area of a rectangle**

A rectangle is a quadrilateral with opposite side's parallel and right interior angles**.** The formula is given by:

- ***REMEMBER:*** In the process of calculating the area, we multiply unit's times units. This will produce a final reading of square units (or units squared). This fits well with the definition of area which is the number of square units that will cover a closed figure.

- **Area of a triangle**

The height of a triangle is the perpendicular distance from any vertex of a triangle to the side opposite that vertex. In other words, the height of triangle is a segment that goes from the vertex of the triangle opposite the base to the base (or an extension of the base) that is perpendicular to the base (or an extension of the base). Notice that in this description of the height of a triangle, we had to include the words “or an extension of the base”.

This is required because the height of a triangle does not always fall within the sides of the triangle. Another thing to note is that any side of the triangle can be a base. You want to pick the base so that you will have the length of the base and also the length of the height to that base. The base does not need to be the bottom of the triangle. You will notice that we can still find the area of a triangle if we don’t have its height. This can be done in the case where we have the lengths of all the sides of the triangle. In this case, we would use Heron’s formula.

- **Area of a parallelogram**

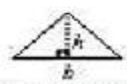
A parallelogram is a quadrilateral with opposite sides parallel. You will notice that this is the same as the formula for the area of a rectangle. A rectangle is just a special type of parallelogram. The height of a parallelogram is a segment that connects the top of the parallelogram and the base of the parallelogram and is perpendicular to both the top and the base. In the case of a rectangle, this is the same as one of the sides of the rectangle that is perpendicular to the base.

- **Area of a trapezoid**

A trapezoid is a quadrilateral that has one pair of sides which are parallel. These two sides are called the bases of the trapezoid. The height of a trapezoid is a segment that connects the one base of the trapezoid and the other base of the trapezoid and is perpendicular to both of the bases.

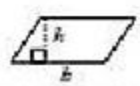
- **Area of a circle**

Planar Figure	Formula
Triangle	$A = \frac{1}{2}(\text{base})(\text{height})$ or $A = \frac{1}{2}bh$



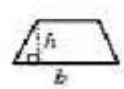
Any side of a triangle can be its base. The height is the length of the perpendicular segment from the opposite vertex to a line containing the base.

Rectangle	$A = (\text{length})(\text{width})$ or $A = lw$
Parallelogram	$A = (\text{base})(\text{height})$ or $A = bh$



Any side of a parallelogram can be its base. The height is the length of the perpendicular segment from the opposite side to a line containing the base.

Square	$A = (\text{side})(\text{side})$ or $A = s^2$
Trapezoid	$A = \frac{1}{2}(\text{base}_1 + \text{base}_2)(\text{height})$ or $A = \frac{1}{2}(b_1 + b_2)h$



The bases of a trapezoid are the parallel sides. The height is the length of the perpendicular segment whose endpoints are on opposite bases.

Circle	$A = \pi(\text{radius})(\text{radius})$ or $A = \pi r^2$

- **Volume:**is the quantity of three-dimensional space enclosed by a closed surface, for example, the space that a substance (solid, liquid, gas, or plasma) or shape occupies or contains. Volume is often quantified numerically using the SI derived unit, the cubic meter. The volume of a container is generally understood to be the capacity of the container, i. e. the amount of fluid (gas or liquid) that the container could hold, rather than the amount of space the container itself displaces.
  - Three dimensional mathematical shapes are also assigned volumes. Volumes of some simple shapes, such as regular, straight-edged, and circular shapes can be easily calculated using arithmetic formulas.
  - The volume of a solid (whether regularly or irregularly shaped) can be determined by fluid displacement. Displacement of liquid can also be used to determine the volume of a gas. The combined volume of two substances is usually greater than the volume of one of the substances. However, sometimes one substance dissolves in the other and the combined volume is not additive.
  - Volume is the measure of the space inside of a three-dimensional solid. In the example

The standard unit of volume in the metric system is the liter.

1 milliliter = 0.001 liter
1 centiliter = 0.01 liter
1 deciliter = 0.1 liter
1 kiloliter = 1000 liters
Abbreviations
1 milliliter = 1 ml
1 centiliter = 1 cl
1 deciliter = 1 dl
1 liter = 1 l
1 kiloliter = 1 kl

Table.5.1. unit conversion

You multiplied a third dimension (height) by the area of the parking space. Height affected the unit of measure changing it from square feet (area covering only length and width) to cubic feet. Volume Formulas for Some Three-dimensional Solids

Shape	Volume Formula
Prism (rectangular)	(length of base)(width of base)(height of prism) = lwh
Cylinder	(area of the base)(height) = $\pi r^2 h$
Pyramid	1/3(area of base)(height) = 1/3Bh
Sphere	$\frac{4}{3}\pi r^3$

Table. 5.2. formula of volume

4.3 unit Conversion

The most commonly used metric measurements of length are shown below.

- ✓ 1000 microns (μ) = 1 millimeter (mm)
- ✓ 10 millimeters = 1 centimeter (cm)
- ✓ 10 centimeters = 1 decimeter (dec)
- ✓ 10 decimeters = 1 meter (m)
- ✓ 10 hectometers = 1 kilometers (km)

The Most Common Metric of Weight (Mass) Measurements is presented below.

- ✓ 10 milligrams (mg) = 1 centigram (cg)
- ✓ 10 centigram = 1 decigram (dg)
- ✓ 10 decigram = 1 gram (g)
- ✓ 10 hectograms = 1 kilogram (kg)

The Most Common Metric of time (second) Measurements is presented below.

- ✓ **1year = 12months**
- ✓ **1months = 30days**
- ✓ **1day= 24hrs**
- ✓ **1hrs = 60min**
- ✓ **1min = 60 sec**

English System of measurements and their relationships

- ✓ 1000 mill-inches = 1 inch
- ✓ 1 foot = 12 inches
- ✓ 1 yard =36 inches
- ✓ 1 yard =3 feet

4.4 Relationships between the Metric and the English Systems

The most often used units of linear measurement in the metric system are the millimeter, centimeter, meter, and kilometer. The relationship between these units and the units of the English system are as follows:

- ✓ 25.4 millimeters = 1 inch (approximately)
- ✓ 2.54 centimeters = 1 inch (approximately)
- ✓ 1 meter = 39.37 inches (approximately)
- ✓ 1 kilometer = 0.62137 miles (approximately 5/8 mile)

The milligram, the gram, and the kilogram are the most often used units of mass (weight) in the metric system. The relationship between these measurements and those of the English system are as follows:

- ✓ 1 milligram = 0.0003527 ounces (approximately)
- ✓ 1 gram = 0.03527 ounces (approximately)
- ✓ 1 kilogram = 2.205 pounds (approximately)

Example 1 Light travels at a velocity of approximately 300,000 km per second. What is the approximate velocity of light in mi per sec?

- ✓ 1 km = 0.62137 mile = 186,000 mi/sec

Example 2. How many kilograms does an 80-pound television set weigh?

1 kg = 2.205lb.

Answer Weight in kg = 2.205 kg/lb × 80 lb = 176.4 kg (Answer)

✓

Example 3 How many inches are there in an antenna that has a length of 30 cm?

Answer

2.54 cm = 1 in.

= 11.8 in.

Example 4 A football field measures 100 yards, what is the length in meters?

Answer

- ✓ (1 meter = one yard = 36 inches, therefore 1 meter = 1.0936 yards.)
- ✓ 100 yards' x 1.0936 meters/yard = 109.36 meters

Self-Check 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I : <u>Mach the following question column A to column B</u>

<u>Column A</u> **<u>Column B</u>**

_______1.

_______2.

_______3.

_______4.

_______5.

Part II. <u>Say true and false for the following question below</u>

_________ 1.

_________ 2.

_________ 3.

_________ 4.

_________ 5.

Part III. <u>Choose the best answer from the question</u>

Answer Sheet

Name: ___________________________ Date: ________________

Satisfactory rating: above 2 **unsatisfactory rating: Below 2**

.

Operation Sheet 2	Measurement and calculation

Procedures for measurement and unit conversation of wire size for socket outlet

1. Identify the type of measuring instrument you use
2. Select wire size for socket outlet
3. Insert the measured wires inside the caliper/micrometer
4. . Read the caliper/micrometer and list the result.
5. Convert the measured unit in to centimeter and inch
6. Report your work and conclusion to your trainer

5.1 Introduction to Numerical computation

Fundamentals of Numerical Computation is an advanced undergraduate-level introduction to the mathematics and use of algorithms for the fundamental problems of numerical computation: linear algebra, finding roots, approximating data and functions, and solving differential equations.

"If mathematical modeling is the process of turning real phenomena into mathematical abstractions, then numerical computation is largely about the transformation from abstract mathematics to concrete reality. Many science and engineering disciplines have long benefited from the tremendous value of the correspondence between quantitative information and mathematical manipulation."

5.2 *Numbers and symbols*

The expression of numerical quantities is something we tend to take for granted. This is both a good and a bad thing in the study of electrical/electronics. It is good, in that we're accustomed to the use and manipulation of numbers for the many calculations used in analyzing electrical/electronic circuits. On the other hand, the particular system of notation we've been taught from grade school onward is *not* the system used internally in modern electronic computing devices, and learning any different system of notation requires some re-examination of deeply ingrained assumptions.

First, we have to distinguish the difference between numbers and the symbols we use to represent numbers. A *number* is a mathematical quantity, usually correlated in electrical/electronics to a physical quantity such as voltage, current, or resistance. There are many different types of numbers. Here are just a few types, for example:

- WHOLE NUMBERS: 1, 2, 3, 4, 5, 6, 7, 8, 9 . . .
- INTEGERS: -4, -3, -2, -1, 0, 1, 2, 3, 4 . . .
- IRRATIONAL NUMBERS: π (approx. 3.1415927), *e* (approx. 2.718281828), square root of any prime numbers
- REAL NUMBERS: (All one-dimensional numerical values, negative and positive, including zero, whole, integer, and irrational numbers)
- COMPLEX NUMBERS: 3 - j4 , 34.5 ∠ 20
- **BINARY ARITHMETICS**

People and computers do not normally speak the same language. Methods of translating information in to forms that is understandable and useable to both are necessary. Humans generally speak in words and numbers expressed in the decimal number system, while computers understand coded electronic pulses that represent digital information. These pulses are defined in the simplest possible number system, which is the binary or base 2 system. The binary system uses only two symbols (0 & 1).

System:	Hash Marks	Roman	Decimal	Binary
-------	----------	-----	-------	------
Zero	n/a	n/a	0	0
One	|	I	1	1
Two	||	II	2	10
Three	|||	III	3	11
Four	||||	IV	4	100
Five	/|||/	V	5	101
Six	/|||/ |	VI	6	110
Seven	/|||/ ||	VII	7	111
Eight	/|||/ |||	VIII	8	1000
Nine	/|||/ ||||	IX	9	1001
Ten	/|||/ /|||/	X	10	1010
Eleven	/|||/ /|||/ |	XI	11	1011
Twelve	/|||/ /|||/ ||	XII	12	1100
Thirteen	/|||/ /|||/ |||	XIII	13	1101
Fourteen	/|||/ /|||/ ||||	XIV	14	1110
Fifteen	/|||/ /|||/ /|||/	XV	15	1111
Sixteen	/|||/ /|||/ /|||/ |	XVI	16	10000
Seventeen	/|||/ /|||/ /|||/ ||	XVII	17	10001
Eighteen	/|||/ /|||/ /|||/ |||	XVIII	18	10010
Nineteen	/|||/ /|||/ /|||/ ||||	XIX	19	10011
Twenty	/|||/ /|||/ /|||/ /|||/	XX	20	10100

Neither hash marks nor the Roman system are very practical for symbolizing large numbers. Obviously, place-weighted systems such as decimal and binary are more efficient for the task. Notice, though, how much shorter decimal notation is over binary notation, for the same number of quantities? What takes five bits in binary notation only takes two digits in decimal notation.

Fraction , decimal and percentage

Percentage can be converted to fraction because' percentage' simply means ' per hundred ' they can also be converted very easily to decimal, which can be useful when using a calculator. Fraction and decimal can also be converted back to percentages

Worked Example 1

Convert each of the following percentages to fractions.

(a) 50% (b) 40% (c) 8%

Solution

(a) $50\% = \frac{50}{100} = \frac{1}{2}$

(b) $40\% = \frac{40}{100} = \frac{2}{5}$

(c) $8\% = \frac{8}{100} = \frac{2}{25}$

Worked Example 2

Convert each of the following percentages to decimals.

(a) 60% (b) 72% (c) 6%

Solution

(a) $60\% = \frac{60}{100} = 0.6$

(b) $72\% = \frac{72}{100} = 0.72$

(c) $6\% = \frac{6}{100} = 0.06$

Worked Example 3

Convert each of the following decimals to percentages.

(a) 0.04 (b) 0.65 (c) 0.9

Solution

(a) $0.04 = \frac{4}{100}$

$= 4\%$

(b) $0.65 = \frac{65}{100}$

$= 65\%$

(c) $0.9 = \frac{9}{10}$

$= \frac{90}{100}$

$= 90\%$

Worked Example 4

Convert each of the following fractions to percentages.

(a) $\frac{3}{10}$ (b) $\frac{1}{4}$ (c) $\frac{1}{3}$

Solution

To convert fractions to percentages, multiply the fraction by 100%. This gives its value as a percentage.

(a) $\frac{3}{10} = \frac{3}{10} \times 100\%$

$= 30\%$

(b) $\frac{1}{4} = \frac{1}{4} \times 100\%$

$= 25\%$

(c) $\frac{1}{3} = \frac{1}{3} \times 100\%$

$= 33\frac{1}{3}\%$

5.3 Addition and subtraction of fraction

The numerator is the top part of a fraction and the denominator is the bottom part of a fraction. When adding or subtracting fraction they must have the same denominator:

Worked Example 1

$$\frac{4}{7} + \frac{5}{7} = ?$$

Solution

As both fractions have the same denominator (7), they can simply be added to give

$$\frac{4}{7} + \frac{5}{7} = \frac{9}{7}$$

$$= 1\frac{2}{7}.$$

Worked Example 2

$$\frac{3}{4} + \frac{2}{5} = ?$$

Solution

As these fractions have different denominators, it is necessary to find the *lowest common denominator*, that is, the smallest number into which both denominators will divide exactly. In this case it is 20, since both 4 and 5 divide into 20 exactly.

$$\frac{3}{4} + \frac{2}{5} = \frac{15}{20} + \frac{8}{20}$$

$$= \frac{15 + 8}{20}$$

$$= \frac{23}{20}$$

$$= 1\frac{3}{20}$$

Worked Example 3

$$\frac{2}{3} + \frac{7}{12} = \ ?$$

Solution

In this example, 12 is the lowest common denominator.

Solution

Here 24 is the lowest common denominator.

$$\frac{5}{8} - \frac{1}{3} = \frac{15}{24} - \frac{8}{24}$$

$$= \frac{15-8}{24}$$

$$= \frac{7}{24}$$

Exercises

1. Give the answers to the following, simplifying them as far as possible.

(a) $\frac{1}{5} + \frac{1}{5}$ (b) $\frac{3}{8} + \frac{1}{8}$ (c) $\frac{5}{7} + \frac{1}{7}$

(d) $\frac{5}{7} - \frac{2}{7}$ (e) $\frac{8}{13} - \frac{5}{13}$ (f) $\frac{7}{9} - \frac{4}{9}$

(g) $\frac{7}{9} + \frac{8}{9}$ (h) $\frac{3}{5} + \frac{4}{5}$ (i) $\frac{6}{7} + \frac{5}{7}$

(j) $\frac{7}{10} - \frac{3}{10}$ (k) $\frac{8}{9} - \frac{5}{9}$ (l) $\frac{4}{15} - \frac{1}{15}$

5.4 Multiplication and division of fraction

- **Multiplication**

When multiplying two fraction, the numerators (top parts should be multiplied together to give the numerator of the result. Similarity, the two denominators should be multiplied together

In general terms,

$$\frac{a}{b} \times \frac{b}{d} = \frac{a \times c}{b \times d}$$

Worked Example 1

$$\frac{3}{4} \times \frac{5}{7} = ?$$

Solution

$$\frac{3}{4} \times \frac{5}{7} = \frac{3 \times 5}{4 \times 7}$$

$$= \frac{15}{28}$$

Worked Example 2

$$\frac{3}{5} \times \frac{7}{12} = ?$$

Solution

$$\frac{{}^{1}\cancel{3}}{5} \times \frac{7}{\cancel{12}_{4}} = \frac{1 \times 7}{5 \times 4}$$

$$= \frac{7}{20}$$

Worked Example 3

$$1\frac{1}{2} \times 3\frac{4}{5} = ?$$

Solution

$$1\frac{1}{2} \times 3\frac{4}{5} = \frac{3}{2} \times \frac{19}{5}$$

$$= \frac{57}{10}$$

$$= 5\frac{7}{10}$$

- **Division**

To understand how to divide with fractions, first consider how multiplication and division are related.

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$$

Take as an example,

$$3 \times 4 = 12.$$

Then it is also true that

$$12 \div 4 = 3.$$

So '$\times 4$' and '$\div 4$' are *inverse* operations.

Note that

$$12 \times \frac{1}{4} = 3,$$

so $\div 4$ is the same as $\times \frac{1}{4}$.

Similarly, because $\div \frac{1}{2}$ is the same as $\times 2$,

$$6 \div \frac{1}{2} = 12 \quad \left(\text{check: } 12 \times \frac{1}{2} = 6\right)$$

and, alternatively, $6 \times 2 = 12$.

So $\div \frac{1}{2}$ is the same as $\times 2$.

You can generalise these examples to give

$$\div a \quad \text{is the same as} \quad \times \frac{1}{a}$$

$$\div \frac{1}{b} \quad \text{is the same as} \quad \times b$$

and combining the two results gives

$$\div \frac{a}{b} \quad \text{is the same as} \quad \times \frac{b}{a}.$$

Worked Example 4

$$\frac{3}{4} \div \frac{7}{8} = ?$$

Solution

$$\frac{3}{4} \div \frac{7}{8} = \frac{3}{{}_{1}\not{4}} \times \frac{\not{8}^{2}}{7}$$

$$= \frac{3 \times 2}{1 \times 7}$$

$$= \frac{6}{7}$$

Self-Check -5	Written Test

Direction: choose the best answer for all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. How many square inches of paint would be on a sphere with a 12 inch diameter?
   A. 48in.^{2}
   B. 144 in.^{2}
   C. 288in.^{2}
   D. 576in.^{2}
2. The area of a rectangle below is 18 square units. What is the perimeter of the rectangle?
   E. 11 units
   F. 16 units
   G. 20 units
   H. 22 units
3. What length of 20mm mild steel plate is needed to form a cylinder having an outside diameter (OD) of 700mm?
   A. 500mm
   B. 650
   C. 680
   D. 600
4. Which one of the following is the SI unit of length?
   A. Kilo gram
   B. Meter
   C. Second
   D. Square meter

Satisfactory rating: 5 and above **unsatisfactory rating: Below 5**

Information Sheet 6	Reading instruments to the limit of accuracy of the tool.

6.1Introduction of reading instrument

A measurement system may be defined as a systematic arrangement for the measurement or determination of an unknown quantity and analysis of instrumentation. The generalized measurement system and its different components/elements are shown in

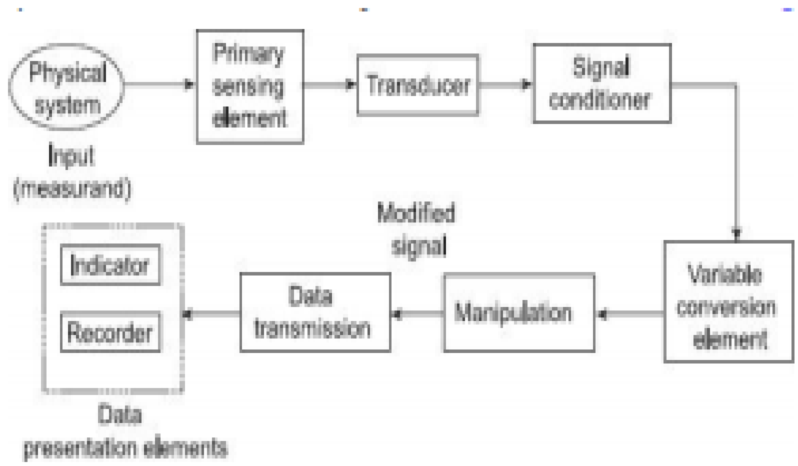


Fig 6.1 generalized measurement system and its different components

The operation of a measurement system can be explained in terms of functional elements of the system. Every instrument and measurement system is composed of one or more of these functional elements and each functional element is made of distinct components or groups of components which performs required and definite steps in measurement.

6.2. DEFINITIONS OF SOME STATIC CHARACTERISTICS

- **Accuracy**
  Accuracy is the closeness with which the instrument reading approaches the true value of the variable under measurement. Accuracy is determined as the maximum amount by which the result differs from the true value. It is almost impossible to determine experimentally the true value. The true value is not

indicated by any measurement system due to the loading effect, lags and mechanical problems (e.g., wear, hysteresis, noise, etc.). Accuracy of the measured signal depends upon the following factors: • Intrinsic accuracy of the instrument itself; • Accuracy of the observer; • Variation of the signal to be measured; and • Whether or not the quantity is being truly impressed upon the instrument.

- **Precision**

  Precision is a measure of the reproducibility of the measurements, i.e., precision is a measure of the degree to which successive measurements differ from one another. Precision is indicated from the number of significant figures in which it is expressed. Significant figures actually convey the information regarding the magnitude and the measurement precision of a quantity. More significant figures imply greater precision of the measurement.
- **Resolution**

  If the input is slowly increased from some arbitrary value it will be noticed that the output does not change at all until the increment exceeds a certain value called the resolution or discrimination of the instrument. Thus, the resolution or discrimination of any instrument is the smallest change in the input signal (quantity under measurement) which can be detected by the instrument. It may be expressed as an accrual value or as a fraction or percentage of the full-scale value. Resolution is sometimes referred as sensitivity. The largest change of input quantity for which there is no output of the instrument is called the dead zone of that instrument.

  The sensitivity gives the relation between the input signal to an instrument or a part of the instrument system and the output. Thus, the sensitivity is defined as the ratio of output signal or response of the instrument to a change of input signal or the quantity under measurement.

7.3. MEASUREMENT OF ERRORS

In practice, it is impossible to measure the exact value of the measured. There is always some difference between the measured value and the absolute or true value of the unknown quantity (measured), which may be very small or may be large. The difference between the true or exact value and the measured value of the unknown quantity is known as the absolute error of the measurement.

Self-Check 6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Say true and false for the following question below

Directions: Give short answer for the following questions.

1 Precision is a measure of the reproducibility of the measurements

2 The sensitivity gives the relation between the input signal to an instrument or a part of the instrument system and the output

3 Resolution is sometimes referred as sensitivity

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**.

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Answer

LAP Test. 1	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary instrument and materials you are required to perform the following tasks within 1hour.

Task 1: Perform the four mathematical operations of four numbers and show the properties of

Each operation

Task2: Convert mixed fraction numbers to percentage and vice versa

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Handling measuring instruments without damage
- Cleaning measuring instruments before and after using.
- Undertaking Proper storage of instruments
  - ✓ manufacturer's specifications and
  - ✓ Standard operating procedures

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Handle measuring instruments without damage
- Clean measuring instruments before and after using.
- Undertake Proper storage of instruments
  - ✓ Manufacturer's specifications and
  - ✓ Standard operating procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 14.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the Self-check 1,
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to "Information Sheet 2". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1
7. Submit your accomplished Self-check. This will form part of your training portfolio.

8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2”
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the “Information Sheets 3 and 4”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3”
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation, proceed to “Operation Sheet 1” However, if your rating is unsatisfactory, see your teacher for further instructions or go back to for each Learning Act

Information Sheet-1	Handling measuring instruments without damage

1.1 **Operational maintenance** is the care and minor maintenance of equipment using procedures that do not require detailed technical knowledge of the equipment's or system's function and design. This category of operational maintenance normally consists of inspecting, cleaning, servicing, preserving, lubricating, and adjusting, as required. Such maintenance may also include minor parts replacement that does not require the person performing the work to have highly technical skills or to perform internal alignment.

As the term implies, operational maintenance, is performed by the operator of the equipment. Its purpose is threefold: (1) to make the operator aware of the state of readiness of the equipment; (2) to reduce the delays that would occur if a qualified technician had to be called every time a simple adjustment were needed; and (3) to release technicians for more complicated work

One of the major problems with the use of bolted joints is the precision, with regard to achieving an accurate preload, of the bolt tightening method selected. Insufficient preload, caused by an inaccurate tightening method, is a frequent cause of bolted joint failure. It is important for the Designer to appreciate the features and characteristics of the main methods employed to tighten bolts. Note however that whatever method is used to tighten a bolt, a degree of bolt preload scatter is to be expected.

1.2 Cleaning

Clean the tools immediately after use.
A wire brush may be useful to loosen the soil stuck to the blades.
Avoid the risk of spreading pathogens while the tools are being cleaned.
Coat the blades with light oil like WD-40 on areas prone to rust.

1.3 **Corrective maintenance** is a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-service operations. Corrective maintenance can be subdivided into "immediate corrective maintenance" (in which work starts immediately after a failure) and "deferred corrective maintenance" (in which work is delayed in conformance to a given set of maintenance rules).

1.4 **Repair and overhaul tools**

Fig. 1.1 Repair and overhaul tools

1. *Torque wrench (small and mid-ranges)*
2. *Conventional, plastic or soft-faced hammers*
3. *Impact driver set*
4. *Vernier gauges*
5. *Circlip pliers*
6. *Set of cold chisels riveting tool set and punches*
7. *Selection of pullers*
8. *Breaker bars external, or combination)*
9. *Chain breaking/*
10. *Wire stripper and crimper tool*
11. *Multi meter (measures amps, volts and ohms)*
12. *Stroboscope (for dynamic timing checks)*
13. *Hose clamp (wingnut type shown)*
14. *Clutch holding tool*
15. *One-man brake/clutch bleeder kit*

Self-Check 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Say true and false for the following question below

Directions: Give short answer for the following questions.

1.________. operational maintenance is performed by the operator of the equipment.

A True B, False

2. ________. Cleaning Clean the tools immediately after use.

A True B. False

3._______ maintenance is not a task performed to identify, isolate, and rectify a fault

A True B. False

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**.

Answer Sheet

Score = ___________

Rating: ____________

Name: ___________________________ Date: ________________

Answer

1._____

2._____

3._____

2.1. Introduction

High-quality handheld measuring devices are among the most important instruments – both in shop floor surroundings as well as in laboratories and quality management departments. They are simple to operate and deliver precise and easy to read results.

Although they boast robust design – some models even an IP class – and long-life expectancy they require proper treatment and care.

This information sheet is explaining the correct care and maintenance necessary to ensure reliable results and a long lifetime of your handheld length measuring instruments

Fig.2.1. high-quality handheld measuring device.

- **Before use**
  - ✓ Make sure type, measuring range, graduation – respectively digital step – and other specifications of the measuring instrument are appropriate for your application.

Fig. 2.2. Application of a point jaw caliper

- ✓ According to EN ISO 1, the reference temperature for length measurement is 20°C. At other temperatures, according to temperature requirements, countermeasures such as compensation become necessary.
- ✓ Remove dust or dirt from the measuring instrument, especially from the measuring surfaces.
- ✓ To clean the instrument, use a soft cloth soaked in a diluted neutral detergent. Do not use any organic solvent (thinner, benzine etc.). These might damage the instrument.
- ✓ To prevent rust, wipe the moveable parts with a cloth moistened with anti-corrosion oil.

Fig.2.3. Remove dust or dirt from the measuring instrument

- ✓ Check to see whether the moveable parts move smoothly without any jamming or unevenness by moving it all the way through its range.
- ✓ Do not disassemble or modify the measuring instrument unless you have a profound knowledge.
- ✓ Set the zero point or reference point before starting measurement. That means bring the measuring surfaces close together (e.g. outside micrometer 0-25 mm) or use an appropriate calibrated master gauge.

Fig.2.4. Reference point setting with a gauge block

- Reference setting and measuring should be carried out under as similar conditions as possible in order to minimize measurement errors.

Fig.2.5. Zero setting with a 10 mm ceramic gauge block if the work piece nominal is 10 mm

- **During Use**
  - ✓ Do not apply excessive force to the measuring instrument.
  - ✓ Make sure to apply constant measuring force during measurement e.g. by using the constant force device of an outside micrometer.

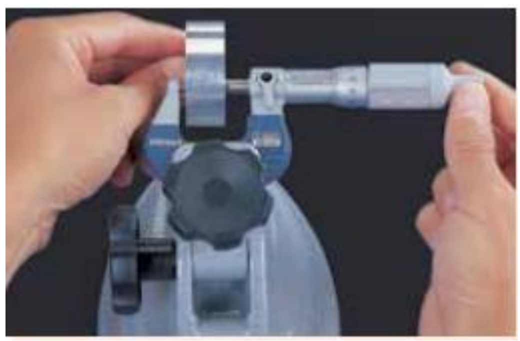


Fig. 2.6. Micrometers ensure constant and reliable measuring force of 5-10 N.

- ✓ Do not use the measuring instrument for other applications than indicated by the specification (e.g. only perform measurement within the measuring range).
- ✓ Perform the measurement in a stable and comfortable measuring position.

Fig.2.7. perform measurement within the measuring range).

- ✓ Leave the measuring instrument and the work piece in the ambient room temperature long enough to adapt to the environment temperature. The ability of a material to conduct heat is specified by the thermal conductivity l [W/(m · K)]. Thermal conductivity is a matter constant. The higher the value, the higher the thermal transfer in relation to time

Table.2.1. specified by the thermal conductivity

	Steel	Aluminium	Cast Iron	Copper	Ceramic	Brass
Thermal Conductivity λ [W/(m · K)]	47-58	appr. 200	appr. 58	appr. 384	appr. 2,9	appr. 113

- ✓ The temperature of measuring tools rises when held in a bare hand. Perform the measurement as fast as possible or protect the instrument against body heat e.g. by using heat-insulating plates or wearing gloves.

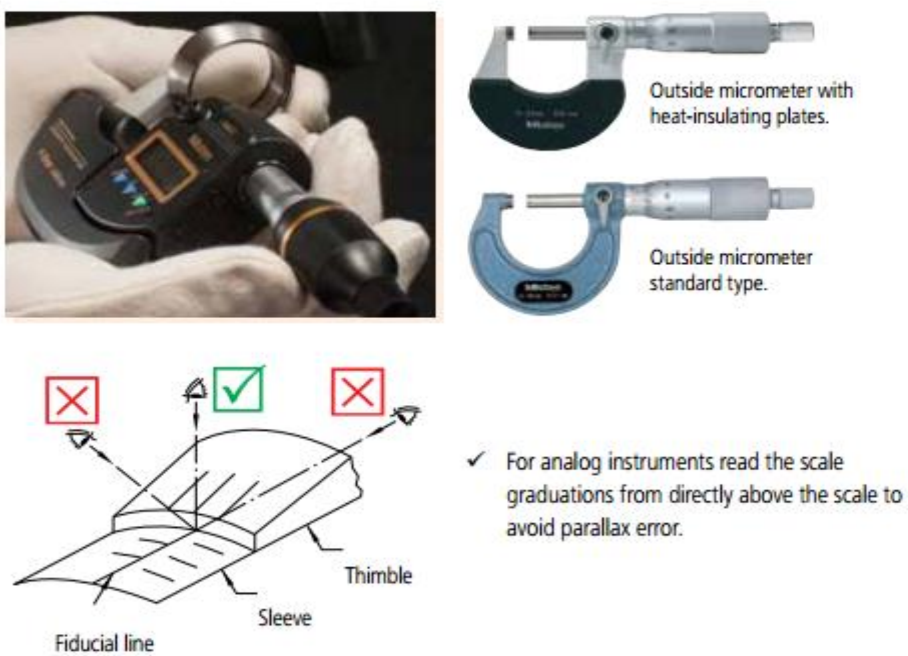


Fig.2.8. using heat-insulating plates or wearing gloves.

- ✓ If using the instrument in long measuring sessions, regularly check (and if necessary adjust) the zero point or reference point.
- ✓ If the instrument is damaged due to being dropped or struck hard do not use it before checking its function and accuracy.
- ✓ Whenever changing the instrument's configuration, like replacing exchangeable contact points, extension rods or any other parts, repeat reference setting.

Fig.2.9. 3-point internal micrometers with exchangeable measuring heads

After Use

- ✓ Check the measuring instrument for damage. Repair or replace if necessary. Clean the instrument.
- ✓ If the instrument was used at places contaminated by soluble cutting oil, perform rust prevention treatment after cleaning.
- ✓ Store the instrument in a room free of excessive heat and moisture. Protect it from dust and oil mist.
- ✓ Before storing the instrument for a long time, apply anti-corrosive coating for rust prevention

Fig.2.10. apply anti-corrosive coating for rust prevention

- ✓ Do not expose measuring instruments to direct sunlight.
- ✓ Store measuring instruments in a case

Fig.2.11Store measuring instruments in a case

2.2. Digital Instruments

Before Use

- ✓ When the battery symbol appears, replace the battery.

Fig. 2.12. calipers battery

- ✓ The supplied batteries (standard) are used only for the purpose of checking the functions and performance of the caliper, therefore they may not reach the specified battery life.
- ✓ Install battery with the positive side up. Use SR44 respectively CR2032 battery type only.

Fig. 2.13. battery with the positive side up

- ✓ After the battery is replaced, clean the measuring faces and bring them into contact. Then press the ORIGIN/PRESET button to perform the zero point setting or reference point setting

Fig. 2.14. Checking the functions and performance of the caliper

- ✓ When tightening the output connector cover and battery cap screws, make sure not to squeeze the rubber seal with the cap or cover.

Fig. 2.15. Rubber seal to protect the battery housing

- ✓ Do not use electric pens to mark the measuring instrument. These may damage the internal circuitry. Any other types of voltage loads should also be avoided.

- **During Use**
  - ✓ If any error occurs or the count is displayed abnormally, remove and reinstall the battery.
  - ✓ The operating temperature is between 5°C and 40°C. The electronic components of digital tools are designed to ensure operation within this temperature range. However, reference temperature for accuracy specification is 20°C, conforming to EN ISO1.
  - ✓ The maximum temperature gradient is 1,5 °C/min. Significant changes in the ambient temperature not only affect the measuring accuracy. The resulting

condensation can damage digital tools, compromise sensor detection and cause corrosion.

- ✓ The relative air humidity must be below 80%. To avoid condensation do not use measuring tools in high relative humidity at length in order to avoid condensation (which compromises sensor detection). It can also cause the parts made from organic materials to swell and have adverse effects to the electric circuits. However, if the ambient air is too dry, static electricity may cause malfunctions.
- ✓ Magnetic or electromagnetic fields generated by a magnetic chuck or a demagnetizer do not state a problem. A demagnetizer can be used on measuring tools. Remove the battery and use the lowest level of the demagnetization instrument for a short time only.
- ✓ Low pressure (< 1,33322 Pa) can damage the LCD and cause the battery to leak.
- ✓ Radioactive radiation will cause deterioration of the ICs and other components.
- ✓ The digital instruments have no explosion prevention and protection.
- ✓ High IP grades (e.g. IP67) should not be misunderstood as a license to careless or even negligent treatment of the equipment. Coolant fluid will eventually cause damage if the instruments are not treated with the proper care throughout their service life.

Fig. 2.16. To check the dimension of gear

- ✓ If the data output and a dedicated cable is used, avoid tensile stress, excessive bending and buckling of the connected cable.

Fig.2.17. Avoid abnormal cable guidance and tensile stress

- ✓ A foot switch eases data transfer from a Dogmatic handheld measuring instrument to a PC or a data collecting device, minimizes operator fatigue and extends the data switch's lifetime.

Fig.2.18-foot switch

- **After Use**

✓ The storage temperature must be between -10°C and 60°C. Parts made of different materials are bonded in digital instruments. Under excessively severe temperature conditions, they may be damaged due to the difference in thermal expansion coefficient between them.

✓ Do not expose digital measuring instruments to ultraviolet radiation at length. They deteriorate the plastic parts and the LCD (liquid crystal display).

✓ If the measuring instrument is not in use for more than 3 months, remove the battery from the instrument. The battery might leak and cause damage.

2.3. Micrometer

- **Outside Micrometer**

Fig. 2.19. Parts of outside micro meter

Before Use

✓ Clamp a sheet of lint-free paper between anvil and spindle, as if measuring its thickness. Slowly draw it away to remove dust or dirt from the measuring faces.

Fig. 2.20. How to use micro meter

✓ Especially when the measuring range exceeds 300 mm, adjust reference point (preset value). In this process – due to frame deflection – the micrometer should be in the same position it will be in when measuring.

- **During Use**
  - ✓ Do not retract the spindle too far past the upper limit of the measuring range. This can damage some types of digital micrometer.

Fig.2.21. Outside micrometer 0-25 mm.

- **Outside Micrometer**
  - ✓ Slowly bring the measuring faces into contact and rotate the ratchet stop several times (1.5 to 2 turns) to apply constant pressure. Excessive force may affect the measurement accuracy.

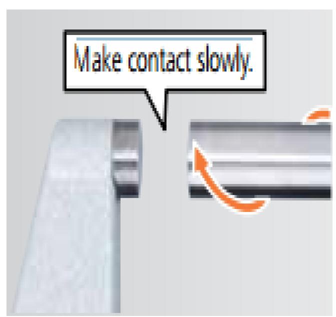


Fig.2.22. make contact slowly

  - ✓ The spindle of the outside micrometer advances 2 mm in one rotation. Its spindle feeds rapidly, so be careful not to feed the spindle too fast during measurement or zero-point adjustment, to prevent the spindle from touching the measurement surface.
  - ✓ When mounting the micrometer on a stand, ensure that the micrometer frame is clamped at the center. Do not clamp it too tightly.

Fig.2.23. spindle pitch Micrometer stand

- **After Use**

✓ Release the spindle clamp, separate the measuring faces by approximately 0.2 to 2 mm, and then store the instrument in a appropriate case. Unlocked ü Always use the ratchet stop, ratchet thimble or friction thimble when measuring.

- **3-Point (line) Internal Micrometer**

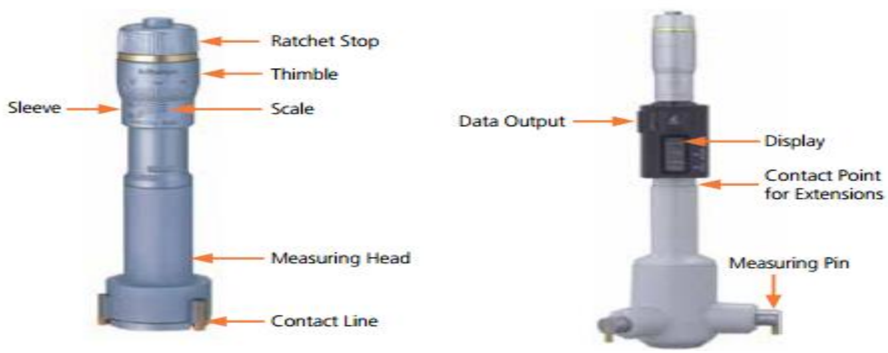


Fig. 2.24. 3-Point (line) Internal Micrometer

- **Before Use**

✓ Perform the initial setting using the calibrated master gauge.

Fig.2.25. calibration of master gauge

- ✓ If measuring using only a part of the measuring surface (contact line), make sure to set the reference point at the same position of the surface. Follow the general guideline: Adjust in the same manner you measure.

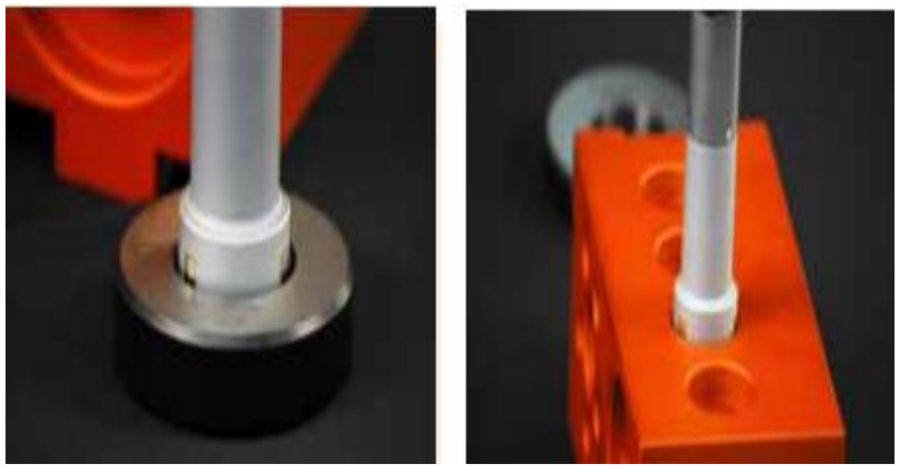


Fig.2.26. A. Setup B. Measuring

- ✓ Note that if the measuring head is replaced or an extension is used, the accuracy specification is no longer guaranteed unless the initial setting is repeated.

- **During Use**
- ✓ Retracting the spindle of a digital 3-point internal micrometer too far past the upper limit of the measuring range will damage the internal micrometer. If resistance is felt do not retract the spindle any further.
- ✓ To apply measuring force, bring the measuring face into light contact with the work piece and hold there. Then operate the ratchet 5 or 6 times (2 to 3 turns) to apply constant force.

Fig.2.27. Retracting the spindle of a digital 3-point internal micrometer

- **After Use**
  - ✓ See all instruments, respectively digital instruments.
- **2-Point Internal Measuring Instruments**

Fig.2.29. 2. Parts of -Point Internal Measuring Instruments

- **Before Use**
  - ✓ Securely tighten the clamping device to lock the gauge in position. If the gauge still moves, clean the gauge stem and the clamping device.

✓ To perform reference setting, a calibrated setting ring, respectively a bore gauge checker with gauge blocks, is recommended.

Fig. 2.30. bore gauge checker with gauge blocks

✓ Set the zero point (midpoint of the measuring range) of the bore gauge, in 0,5 mm increments, to the appropriate median of the bore diameter range. Example: Nominal value of the hole: 54 mm

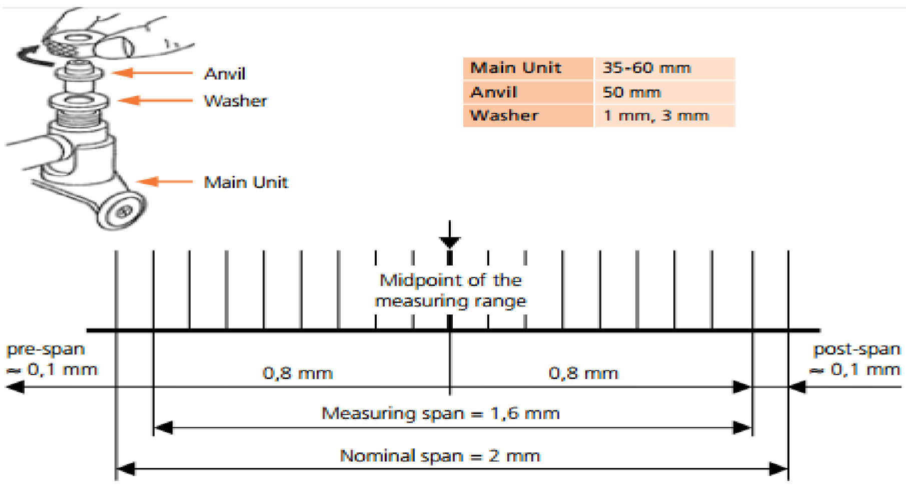


Fig. 2.31. Measuring range and parts of gauge

- **During Use**

✓ To insert the bore gauge into the hole to be measured or a setting ring (for reference point setting), tilt the handle so that the guides enter first, followed by the anvil, as shown below.

Fig. 2.32. bore gauge into the hole to be measured

- **2-Point Inside Measuring Instruments**
  - ✓ Note the correlation between the directions of the contact point displacement and indicator's pointer rotation. The clockwise rotation of the pointer from the reference point indicates that the measured dimension is smaller than the set value. Counter-clockwise pointer rotation from 20 the reference point indicates that the measured dimension is larger than the set value

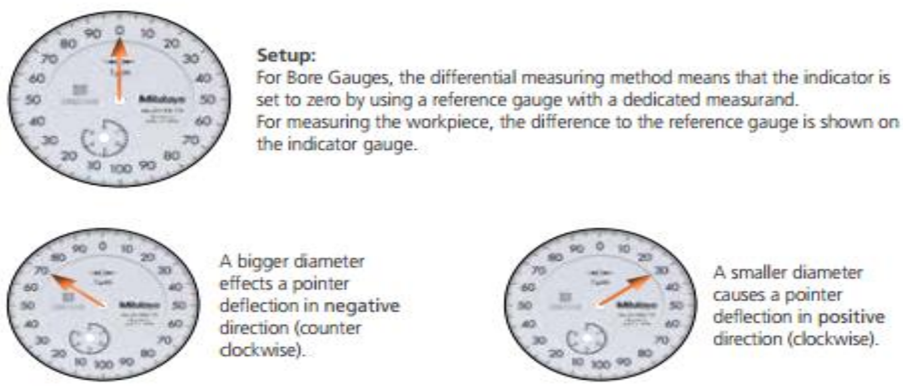


Fig.2.33. **2-Point Inside Measuring Instruments**

- **After Use**
  - ✓ Store the bore gauge with the indicator removed.
  - ✓ If contamination is suspected inside the measuring or the sliding section, clean the inside of the head with a diluted neutral detergent after disassembling using snap-ring pliers. After cleaning, dry completely and apply a film of micrometer oil to the contact point and the driver pin.

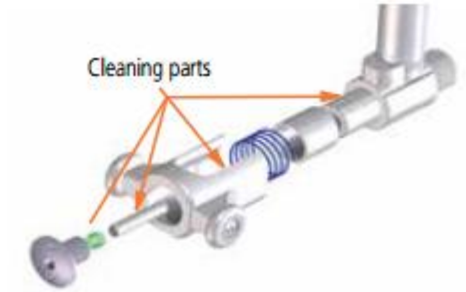


Fig.2.34. film of micrometer oil to the contact point and the driver pin

2.1Calipers

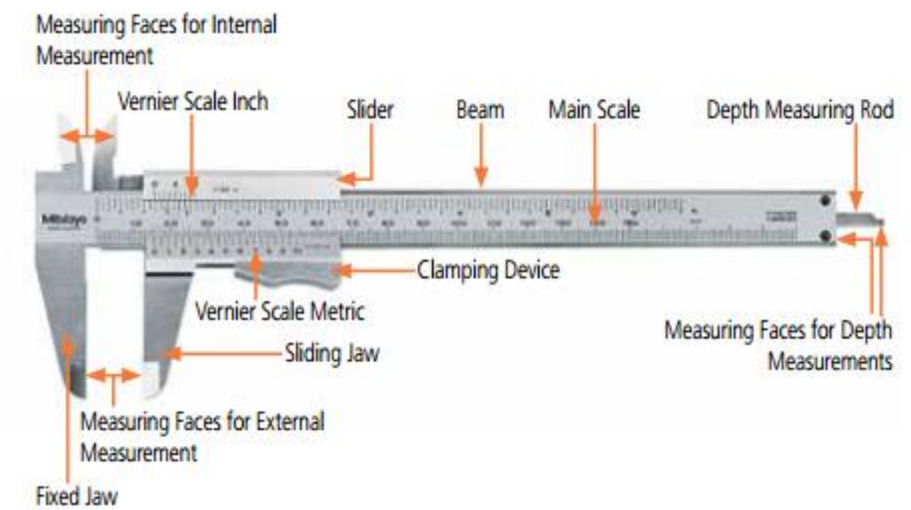


Fig.2.36. parts of calipers

- **Before Use**
  - ✓ Close the measuring faces after cleaning and check the following: Outside measuring faces are in good condition if no light can be seen between them when they are held against a light source. If the faces show contamination or burrs, they will not close properly on their full length and light will be seen between them. Inside measuring faces are in good condition if only little light can be seen between them when they are held against a light source.
- **During Use**
  - ✓ Make sure to apply constant force during measurement and measure the work piece as close to the scale as possible.

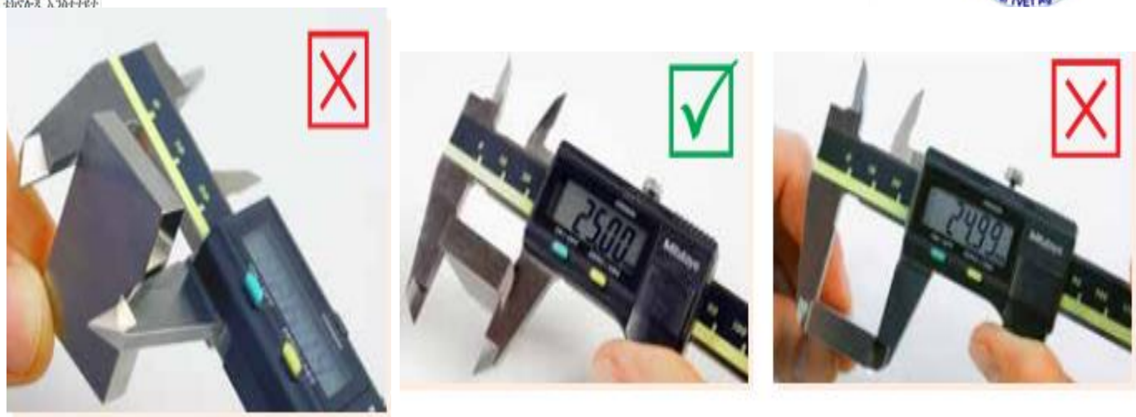


Fig.2.37. correct use of calipers

- ✓ Do not measure an object with the measuring faces tilted.
- ✓ The knife edges for hole measurement should not be used for holes smaller than app. 3 mm in diameter. Otherwise a relatively big measurement error caused by the inside measuring jaws will occur and have to be compensated.

- **After Use**

- ✓ Open the outside measuring jaws by approximately 0.2 to 2 mm, leave the locking screw enlightened and then store the instrument in a proper case.

Fig. 2.38. Proper store of calipers

2.5. Height Gauges

fig 2.39. detail parts of height gauge

- **Before Use**
  - ✓ Set the stylus as close to the main beam as possible. ü Clean beams, instrument reference base, stylus mounting surface as well as the granite surface plate on which the height gauge will be used.
  - ✓ When carrying the instrument, hold it with one hand on the top and the other on the base.

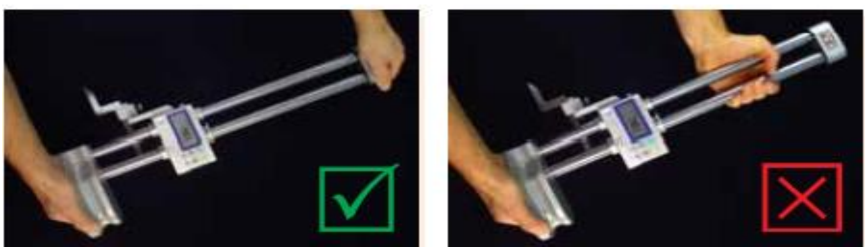


Fig.2. 40. Proper usage of gauge.

- **During Use**
  - ✓ Rotate the feed wheel slowly when applying a constant measuring force. Coarse feed or fine feed (if available) can be selected by pulling or pushing the handle of the slider feed wheel.

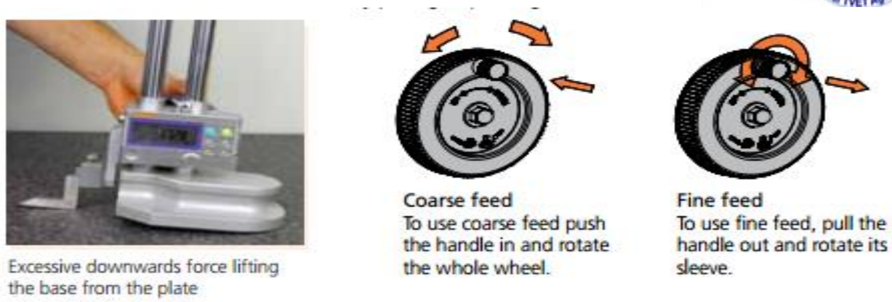


fig.2.41. pulling or pushing the handle of the slider feed wheel

- **After Use**
  - ✓ When the height gauge will not be used for some time leave the scriber unclamped and just above, but not touching, the surface plate. This is to avoid injury by accidental contact with the scriber tip.
  - ✓ Be especially careful not to let the scriber protrude over the edge of the surface plate at any time.

Fig. 2.42. Correct use gauge

✓ If the instrument will not be used for a long time, cover the unit with the supplied dust cover.

Fig. 2.43. cover the gauge after use

2.6. Indicators

Fig.2.44. parts of indicator

- **Before Use**

✓ When setting the zero point, retract the plunger by at least 0.2 mm from the rest position.

✓ To avoid measuring error due to non-perpendicular positioning (plunger to table), ensure that the plunger is accurately aligned with the intended direction of measurement. Also note that unevenness of the reference surface may cause measuring errors.

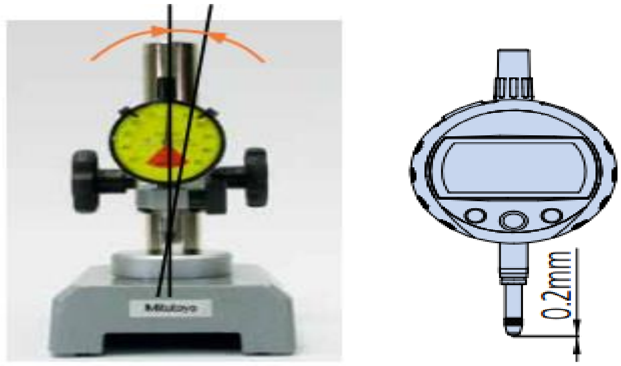


Fig. 2.45. Positioning error

- ✓ Use the contact point that fits the application best.

Fig.2.46. pin of indicator

- ✓ Use a holding fixture that will not deflect significantly during normal use.
- ✓ If the pointer and revolution counter are significantly out of position at the rest point (where the spindle is fully extended), the device may suffer mechanical damage.

- **During Use**
  - ✓ Do not move the plunger rapidly or apply force in transverse direction, otherwise operation and accuracy may be adversely affected.
  - ✓ Use a lifting lever, a spindle lifting cable or any other appropriate device to release the plunger from the work piece.

Fig. 2.47. Application with spindle lifting cable.

- **After Use**

✓ See all instruments, respectively digital instruments

2.7. Dial Test Indicators

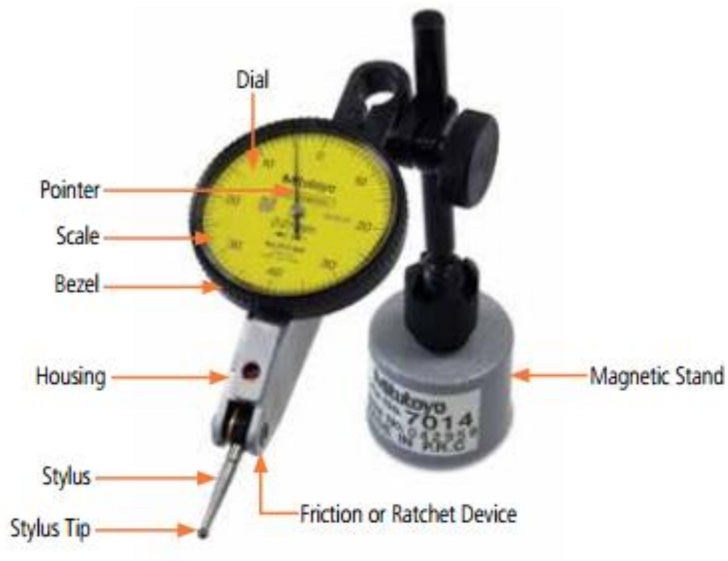


Fig. 2.48. Parts of dial test indicator.

- **Before Use**

✓ Be sure to use the stylus with standard length matching the indicator model, otherwise a large measuring error may be the result.

Fig.2.49. correct use of dial test indicator

✓ Use a holding fixture that will not deflect significantly during normal use.

✓ A Dial Test Indicator's scale factor depends on the angle between the directions of movement of stylus and work piece. In practice, to avoid significant error, if the angle θ is kept less than 10° during measurement, then the effect can be ignored. If this angle cannot be kept small, the dial reading has to be multiplied by a factor to compensate this so-called cosine effect.

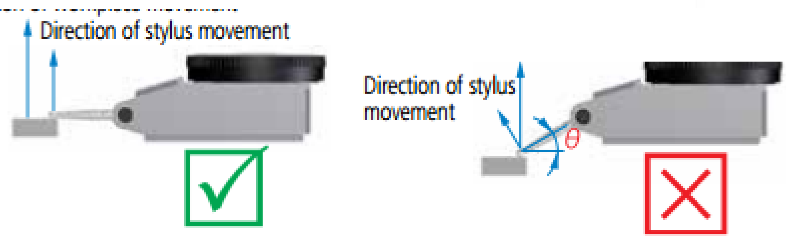


Fig. 2.50. Direction of work piece movement

- ✓ When measuring a rotating or moving work piece or when moving the dial test indicator, ensure that it rotates or moves away from the contact point.

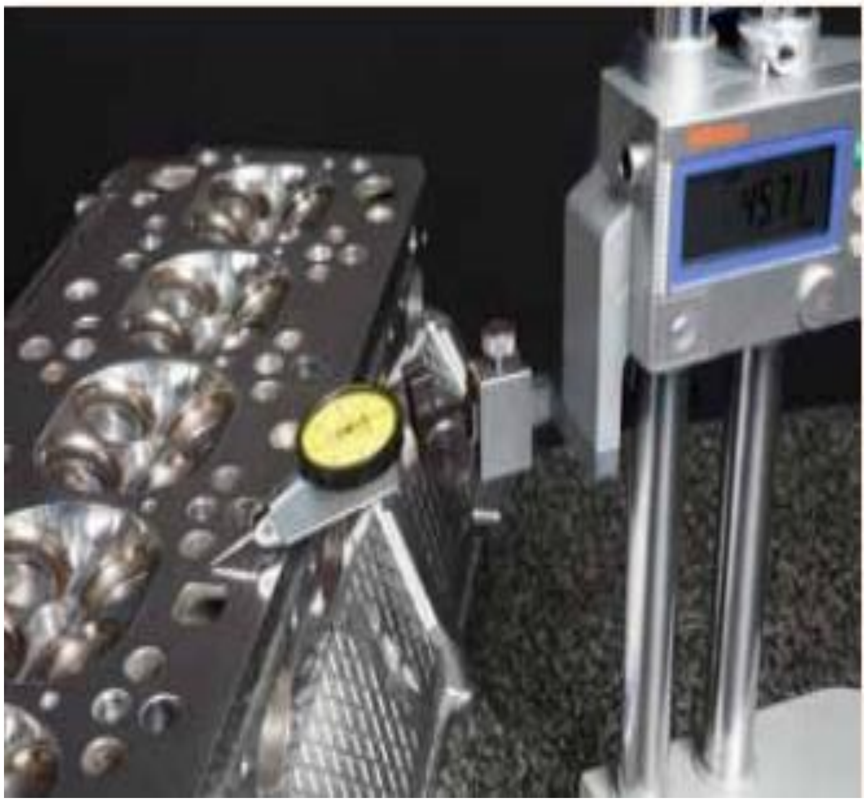


Fig. 2.51. Measurement direction

- **After Use**
  - ✓ See all instruments, respectively digital instruments.

2.8. Depth Measuring Instruments

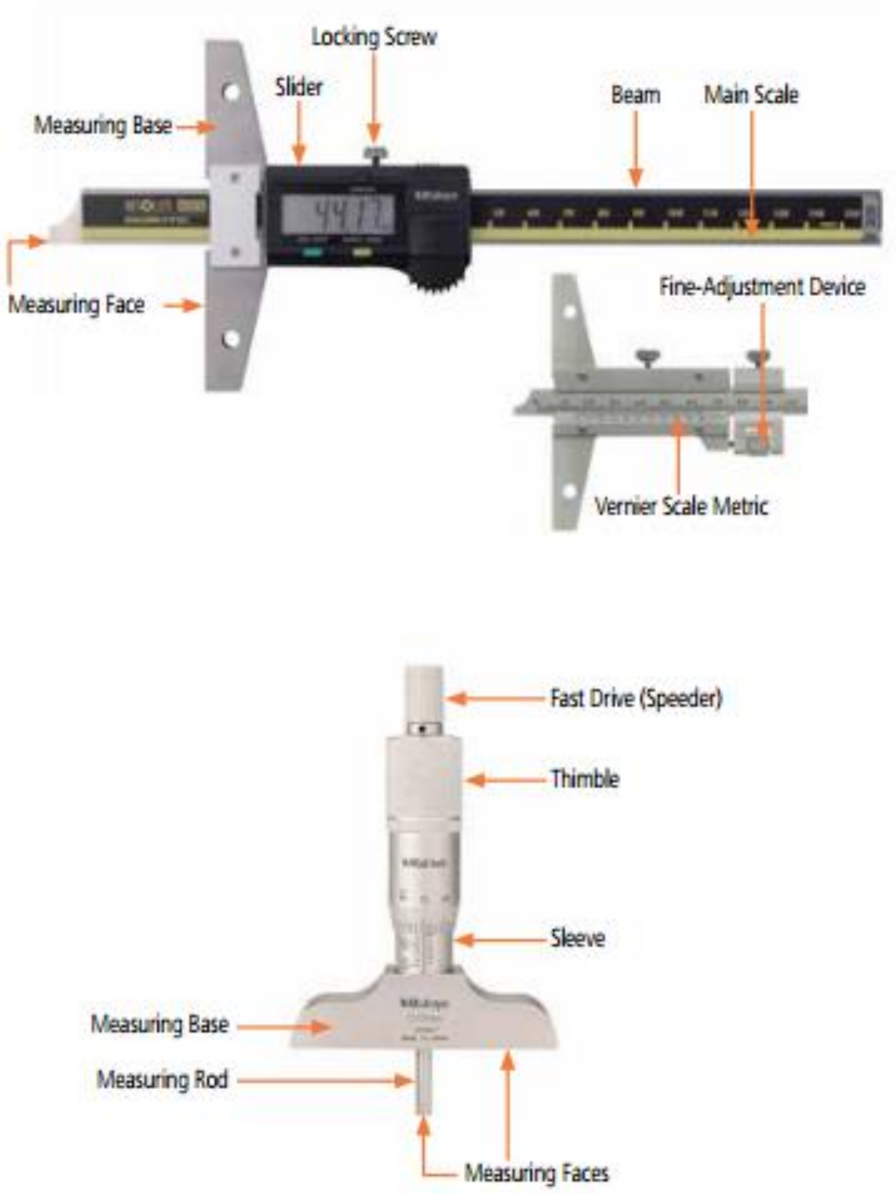


Fig. 2.52. Parts of depth measurement.

- **Before Use**
  - ✓ Slowly bring the movable measuring face (rod/beam) into contact while pressing the fixed measuring face (base) against a flatness-assured surface such as a precision surface plate. Then setup the reference point, if necessary. Use gauge blocks to check the setting of depth micrometers if the reference point is over 25 mm and of indicator depth gauges with extension rods.

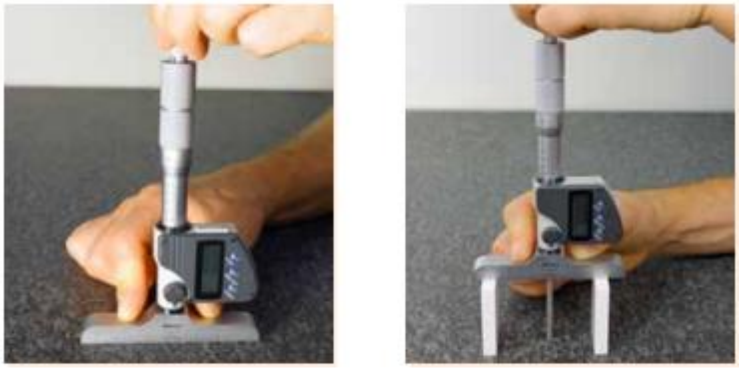


Fig. 2.52. Use gauge blocks to check the setting of depth micrometers

- ✓ When changing the rods of depth micrometers, remove dust or dirt from the contacting surfaces on the rod collar and spindle end.

Fig.2.53. contacting surfaces on the rod collar and spindle end.

- **During Use**
  - ✓ Perform measurement while the reference surface (base surface and measuring surface) is fully in contact with the work piece.
  - ✓ Take care, that the base is always sufficiently pressed down against the work piece to avoid tilting due to measurement force

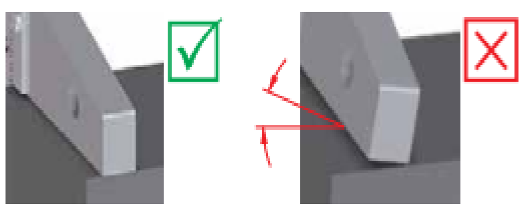


Fig. 2.54. Correct usage of depth measurement.

✓ If the total length of extension rods used with an indicator depth gauge exceeds 110 mm use the gauge in vertical orientation only.

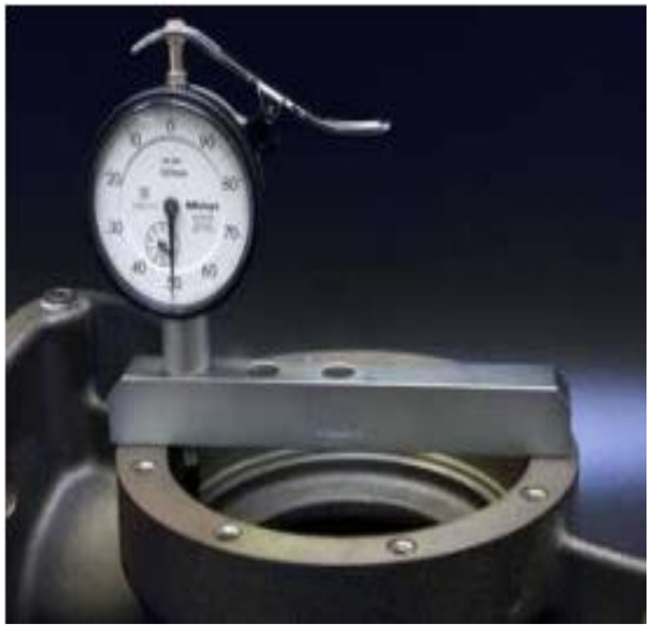


Fig. 2.55. Use the gauge in vertical orientation only.

- **After Use**

✓ See all instruments, respectively digital instruments.

2.9. Auxiliary Equipment Comparator Stands

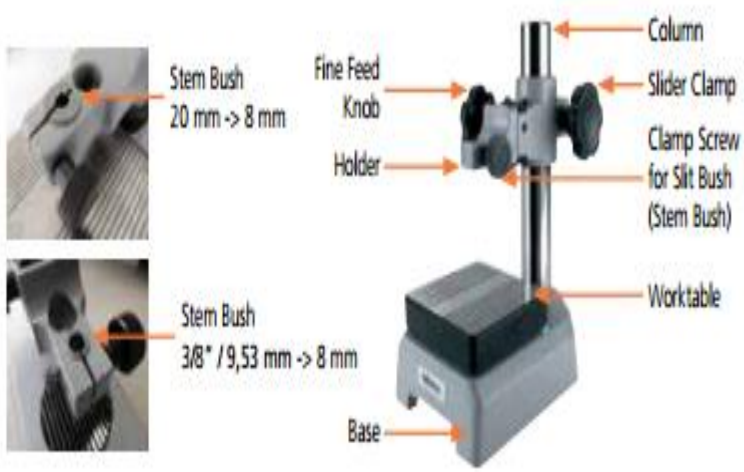


Fig.2.56. parts of Auxiliary Equipment Comparator Stands

- **Before Use**
  - ✓ Clean the worktable using a dry cloth or a cloth moistened with alcohol.
  - ✓ Make sure to hold the bracket firmly when moving it up or down. ü Mount the indicator in the stem mounting hole and tighten the clamp screw. Clamp the indicator firmly. However, the plunger of the indicator must still move smoothly.
  - ✓ After adjusting the measuring position, tighten the slider clamp before starting measurement.
  - ✓ For reference point adjustment, it is recommended to use a gauge block or a master work piece.

Fig.2.57. Reference point setting with a 50 mm Gauge Block.

- **During Use**
  - ✓ Especially for high-accuracy measurements move the plunger of the indicator upwards and downwards using any spindle lifting device such as a spindle lifting cable or a spindle lifting lever to avoid excessive force when changing the measurement equipment.

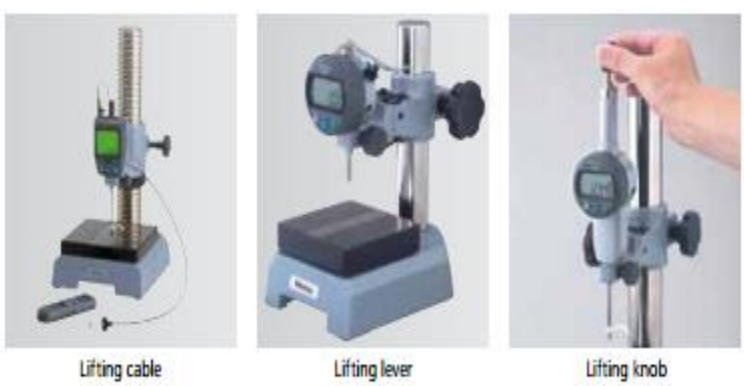


Fig. 2.58. high-accuracy measurement.

After Use

See all instruments, respectively digital instruments.

2.10. Gauge Blocks

Fig. 2.59. parts of gauge block

Before Use

- ✓ To obtain maximum benefit from the extreme accuracy of gauge blocks, use them in a thermally stable environment.
- ✓ Wipe off the oil film from the gauge blocks using a soft cloth and petroleum ether.
- ✓ After wiping, the surfaces are cleaned with a cosmetic brush rinsed with petroleum ether and then blown clean with bellows.
- ✓ Never use alcohol or benzene for cleaning; benzene contains impurities and alcohol always contains aqueous components which may cause corrosion.
- ✓ Best-suited for wiping gauge blocks are microfibre cloths.
- ✓ Check the cleaned gauge blocks for rust and scratches.
- ✓ If there are burrs on the measuring surface remove them carefully using a special Creston for gauge blocks. Move the dry gauge block over the Cranston with very little pressure.

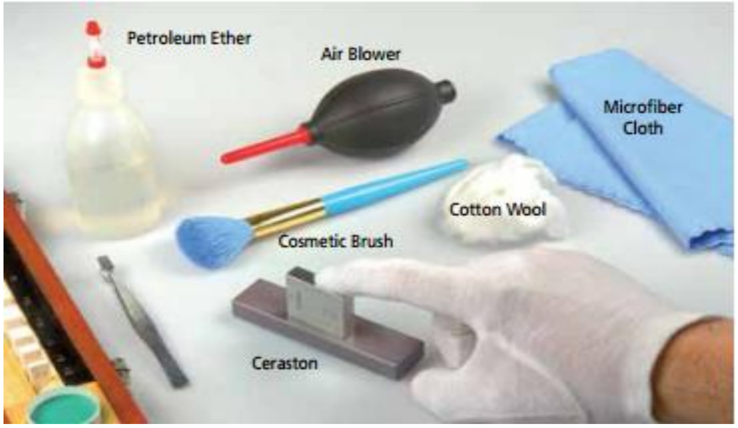
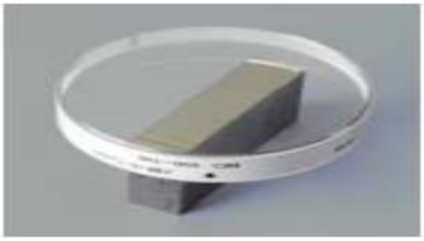


***Fig.2.60.** Accessories for Gauge Block preparation*



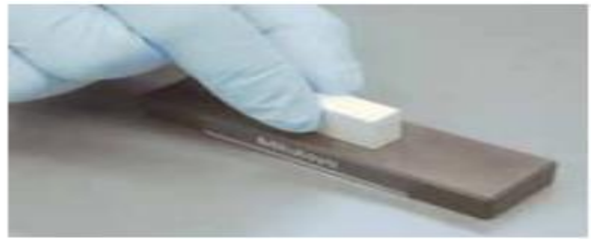


Fig. 2.61. A. *Optical flat to check the measuring face* ***B****. Cranston*

During Use

Wringing should always be performed in a clean place on a soft pad – if gauge blocks slip out of your hand, they will not be damaged.

- ✓ In case the measuring surfaces are in good condition, but wringing is still difficult, you may wipe them with medical cotton wool – its oily components will provide a fine film, thus improving the grip of the measuring surfaces.

After Use

- ✓ Check for damage to the blocks and, if found, recondition them by the method described above. If this is ineffective, replace.
- ✓ After using steel gauge blocks, clean and apply rust prevention treatment using a cloth moistened with anti-corrosion oil.

Fig. 2.62. After using steel gauge blocks, clean and apply rust prevention treatment

2.11. WEEE Disposal of Batteries and Measuring Instruments

Disposal of batteries

- ✓ Batteries contain materials that can harm the environment when treated as conventional waste. On the other hand, most of these materials can be recycled, saving valuable resources. Therefore, for disposing of old batteries you are obliged to hand them to a certified battery collecting point.

Disposal of measuring equipment

- ✓ Disposal of measuring equipment ü Disposal of Old Electrical & Electronic Equipment (applicable in the European Union and other European countries with separate collection systems)
- ✓ This symbol on the product or on its packaging indicates that this product shall not be treated as household waste. To reduce the environmental impact of WEEE (Waste Electrical and Electronic Equipment) and minimize the volume of WEEE entering landfills, please reuse and recycle.

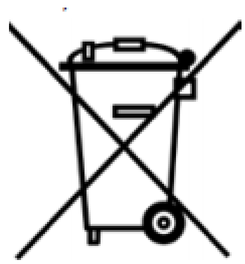


Fig. 2.63. Disposal of Old Electrical & Electronic Equipment

Self-Check 2.	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Say true and false for the following question below

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**.

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Answer

Information Sheet-3	Undertaking Proper storage of instruments

Introduction

Proper way of storing material should be considered in schoolwork shops and training area and this has to be adopted in the real work of electrical work shop. It is use full to keep materials in a proper manner, to preserve materials long lasting, to secure chemical character of the material, for easy access and handling etc. In general proper way of storing material saves time and money. Accordingly, methods of storing for some materials and hand tools are described and illustrated below. Storing materials and tools depend up on the type, size, and product character, etc.

Instruction Sheet 4	Learning Guide #42 Maintain measuring instruments

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying object or component to be measured
- Obtaining correct specifications from relevant source
- Selecting measuring tools

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify object or component to be measured
- Obtain correct specifications from relevant source
- Select measuring tools

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 14.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the Self-check 1,
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2”

10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the "Information Sheets 3 and 4". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the "Self-check 3"
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation, proceed to "Operation Sheet 1" However, if your rating is unsatisfactory, see your teacher for further instructions or go back to for each Learning Act

1.1. **A straightedge is**: a tool used for drawing straight lines, or checking their straightness. If it has equally spaced markings along its length, it is usually called a ruler. Straightedges are used in the automotive service and machining industry to check the flatness of machined mating surfaces. True straightness can in some cases be checked by using a laser line level as an optical straightedge: it can illuminate an accurately straight line on a flat surface such as the edge of a plank or shelf.

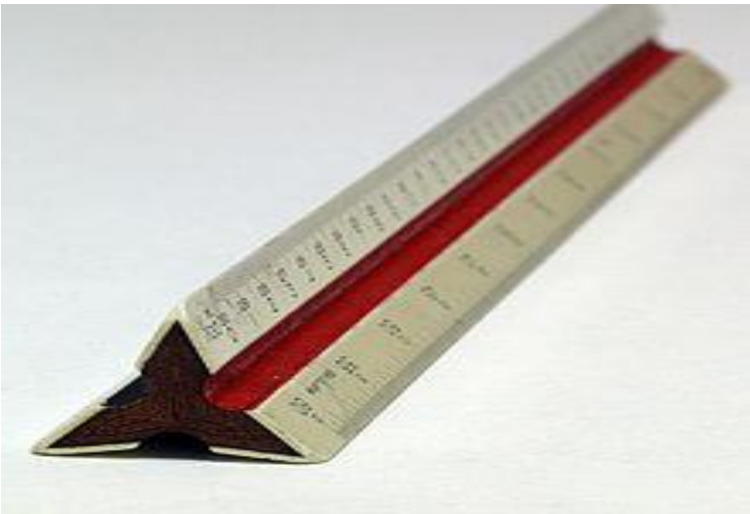


Fig.1.1. Straight edge

A pair of straightedges called winding sticks is used in woodworking to amplify twist (wind) in pieces of wood.

An idealized straightedge is used in compass-and-straightedge constructions in plane geometry. It may be used:

- Given two points, to draw the line connecting them.
- Given a point and a circle, to draw either tangent.
- Given two circles, to draw any of their common tangents.

It may not be marked or used together with the compass so as to transfer the length of one segment to another. It is possible to do all compass and straightedge constructions without the straightedge. It is not, however, possible to do all constructions using only a straightedge. It is possible to do them with straightedge alone given one circle and its center

1.2. TORQUE MEASURING TOOLS

The Torque Measurement tool is used in the manufacturing and engineering industries to check, determine or apply the correct level of torque. It monitors by detecting loosening torque and the

tightening of screws therefore it performs a critical role in the audit, inspection, production, quality control, research, development and servicing environments.

A torque wrench is a tool used to apply a specific torque to a fastener such as a nut or bolt. It is usually in the form of a socket wrench with special internal mechanisms.

- A t**orque wrench** is used where the tightness of screws and bolts is crucial. It allows the operator to set the torque applied to the fastener so it can be matched to the specifications for a particular application. This permits proper tension and loading of all parts. A torque wrench uses torque as a proxy for bolt tension. The technique suffers from inaccuracy due to inconsistent or un calibrated friction between the fastener and its mating hole. Measuring bolt tension (indirectly via bolt stretch) is actually what is desired, but often torque is the only practical measurement which can be made.

Fig. 1.2. torque wrench

- **Torque gauges with wrench sensor**

Ideal to measure torque on bolt and using the Centor technology, the digital torque gauge Centro TW with wrench sensor has a very large graphic display and shows a maximum amount of information for more efficient torque measurement.

Fig. 1.3. torque gauge

- . **Torque gauges with handle sensor**

The torque tester Centor TH, with its handle torque sensor, is an instrument designed to measure manually torque on screws, bolts, tools... directly in production.

Fig. 1.4. torque gauge with handle sensor.

1.3. **A try square** is a woodworking tool used for marking and measuring a piece of wood. The square refers to the tool's primary use of measuring the accuracy of a right angle (90 degrees); to try a surface is to check its straightness or correspondence to an adjoining surface. "Try square" is so called because it is used to "try" the squareness.

Fig. 1.4. Try square.

A piece of wood that is rectangular, flat, and has all edges (faces, sides, and ends) 90 degrees is called four squares. A board is often milled four squares in preparation for using it in building furniture. A traditional try square has a broad blade made of steel that is riveted to a wooden handle or "stock". The inside of the wooden stock usually has a brass strip fixed to it to reduce wear. Some blades also have graduations for measurement. Modern try squares may be all-metal, with stocks that are either die-cast or extruded.

1.4. **A protractor** is a measuring instrument, typically made of transparent plastic or glass, for measuring angles. Most protractors measure angles in degrees (°). Radian-scale protractors measure angles in radians. Most protractors are divided into 180 equal parts. Some precision protractors further divide degrees into arc minutes. They are used for a variety of mechanical and engineering-related applications. One common use is in geometry lessons in schools. Some protractors are simple half-discs. More advanced protractors, such as the bevel protractor, have one or two swinging arms, which can be used to help measure the angle.

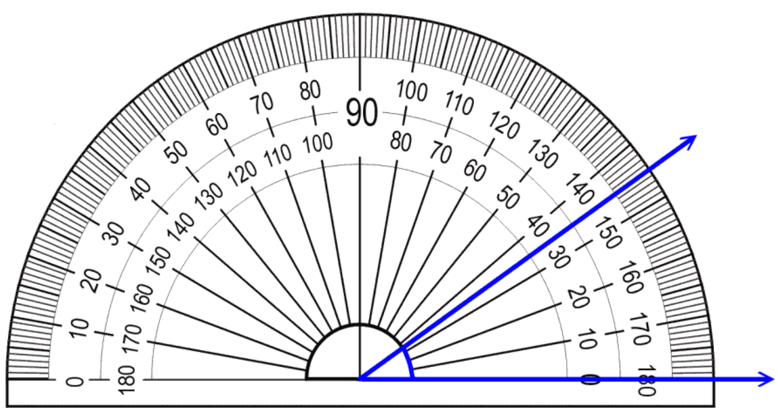


Fig. 1.6. protractor

1.5. **A combination square**: consisting of the rule, 45° holder, protractor and center square A combination square is a tool used for multiple purposes in woodworking , stonemasonry and metalworking . It is composed of a ruler and one or more interchangeable heads that may be affixed to it. The most common head is the standard or square head which is used to lay out or check right and 45° angles. the combination square continues to be a commonplace tool in home workshops, construction jobsites and metalworking.

Fig. 1.7. combination square Uses

- Measuring angles — A combination square can reliably measure 90° and 45° angles.
  The 45° angle is used commonly in creating miter joints .
- Determining flatness — When working with wood the first step is to designate reference
  surface on a board which is known as the face side.

The rest of the work piece is measured from the face side. Measuring the center of a circular bar or dowel. The rule is assembled through the center of the center square, the two cast iron legs of the center square are then placed against the outside of the bar (dowel) allowing a center line to be scribed alongside the ruler. Perform this action at two locations and the intersecting lines will approximate the center of the bar (dowel).

Protractor head allows angles to be set and measured between the base and ruler.

A rudimentary level for approximating level surfaces is incorporated in the protractor and also the 45° holder.

By moving and setting the head, it can be used as a depth gauge or to transfer dimensions.

Marking the work surface; with the included Scribe Point stored in a drilled hole in the Square Base. It is used to find the center of the round jobs.

In woodworking, the starting raw material is neither flat nor square, however, the end product such as a table must be flat and have corners and legs which are square.

In metalworking, it is useful for a wide variety of layout and setup tasks. When used correctly, a fairly high degree of precision can be achieved. One use would be setting large items at the required angle in machine vises, where the long reach of the rule and firm, heavy base aid the process

1.6. **A ruler** sometimes called a rule or line gauge, is a device used in geometry and technical drawing, as well as the engineering and construction industries, to measure or draw straight lines. Rulers have long been made from different materials and in multiple sizes. Some are wooden. Plastics have also been used since they were invented; they can be molded with length markings instead of being scribed. Metal is used for more durable rulers for use in the workshop; sometimes a metal edge is embedded into a wooden desk ruler to preserve the edge when used for straight-line cutting. 12 in or 30 cm in length is useful for a ruler to be kept on a desk to help in drawing. Shorter rulers are convenient for keeping in a pocket. Longer rulers, e.g., 18 in (46 cm) are necessary in some cases. Rigid wooden or plastic yardsticks, 1 yard long, and meter sticks, 1 meter long, are also used. Classically, long measuring rods were used for larger projects, now superseded by tape measure, surveyor's wheel or laser rangefinders.

- **Desk rulers** are used for three main purposes: to measure, to aid in drawing straight lines and as a straight guide for cutting and scoring with a blade. Practical rulers have distance markings along their edges.

A line gauge is a type of ruler used in the printing industry. These may be made from a variety of materials, typically metal or clear plastic. Units of measurement on a basic line gauge usually in cinches, agate, picas, and points. More detailed line gauges may contain sample widths of lines, samples of common type in several point sizes, etc.

Fig. 1.8. Steel ruler or line gauges

Measuring instruments similar in function to rulers are made portable by folding (carpenter's folding rule) or retracting into a coil (metal tape measure) when not in use. When extended for use,

they are straight, like a ruler. The illustrations on this page show a 2 m (6 ft 7 in) carpenter's rule, which folds down to a length of 25 cm (10 in) to easily fit in a pocket, and a 5 m (16 ft) tape, which retracts into a small housing.

Fig.1.9. carpenter's ruler

A flexible length measuring instrument which is not necessarily straight in use is the tailor's fabric tape measure, a length of tape calibrated in inches and centimeters. It is used to measure around

a solid body, e.g., a person's waist measurement, as well as linear measurement, e.g., inside leg. It is rolled up when not in use, taking up little space.

Fig1.1flexible length measuring instrument

self check	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Choose the best answer from the question below

____________1. Which one of the following to check the flatness of machined mating surfaces.

A. Micrometer

B. Straight edge

C. Steel ruler

D. All

___________2. Which one of the following is apply the correct level of torque?

A. Steel ruler
B. Plastic ruler
C. Torque wrench
D. micrometer

___________3. Which one of the following is simple half-discs instrument?

A. Protractor
B. Ruler
C. Torque gauge
D. None

___________4. Which one of the following is marking and measuring a piece of wood?

A. Steel ruler
B. Multi meter
C. Try square
D. micrometer

Answer Sheet

Name: ____________________ Date: ________________

Answer

1.
2. .
3. .
4. .
5.

Score = ___________
Rating: ____________

Information Sheet 2	Obtaining correct specifications from relevant source

2.1. Obtaining correct specifications

“Specifications” is a general term applying to all directions, provisions, and requirement pertaining to the performance of the work and payment for the work. Technician metrology is defined as the measurement of dimensions: length, thickness, diameter, taper, angle, flatness, profiles and others. An important aspect of metrology in manufacturing processes is dimensional tolerances. That is, the permissible variation in the dimensions of a part. Tolerances are important not only for proper functioning’s of products, they also have a major economic impact on manufacturing costs. A specification often refers to a set of documented requirements to be satisfied by a material, design, product, or service. A specification is often a type of technical standard.

There are different types of technical or engineering specifications (specs), and the term is used differently in different technical contexts. They often refer to particular documents, and/or particular information within them. The word *specification* is broadly defined as "to state explicitly or in detail" or "to be specific".

A specification may refer to a standard which is often referenced by a contract or procurement document, or an otherwise agreed upon set of requirements (though still often used in the singular). In any case, it provides the necessary details about the specific requirements.

Standards for specifications may be provided by government agencies, standards organizations.), trade associations, corporations, and others.

2.2. Well-written specifications:

- are clear, concise, and technically correct.
- do not use ambiguous words that could lead to misinterpretation.
- are written using simple words in short, easy to understand sentences.
- use technically correct terms, not slang or “field” words.
- avoid conflicting requirements.
- do not repeat requirements stated elsewhere in the Contract.

do not explain or provide reasons for a requirement.

• state construction requirements sequentially.

• avoid the use of awkward phrases such as “and/or” and “him/her.” Rewriting the sentence can eliminate such phrases.

Furthermore, the phrases “approved by the Engineer” or “accepted by the Engineer” should be avoided. These should be used only when the Engineer will actually accept or approve the work. In such phrases, “approved” and “accepted” are synonymous; there is no difference in the responsibility taken by the Engineer

a. A **requirement specification** is a documented requirement, or set of documented requirements, to be satisfied by a given material, design, product, service, etc..In engineering, manufacturing, and business, it is vital for suppliers, purchasers, and users of materials, products, or services to understand and agree upon all requirements.

The reading of the measured value of instruments vary in accordance with type and correctness of that instrument. The measuring instrument can be chosen by the following criteria.

b. Using alternative measuring instruments

Precision has not always been associated with measurement. At the dawn of civilization, man began to use parts of the body to estimate dimensions, from such measurements, there evolved the first standards of measurement: the inch, hand, span, foot, cubit, yard and fathom. The tools of the past did not demand great accuracy. Most products were custom made by hand and a fraction of an inch one way or the other made little difference to satisfactory operation.

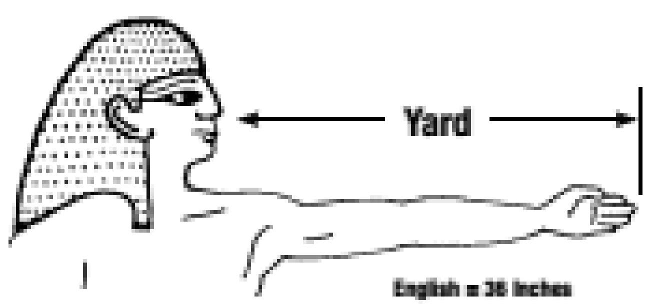
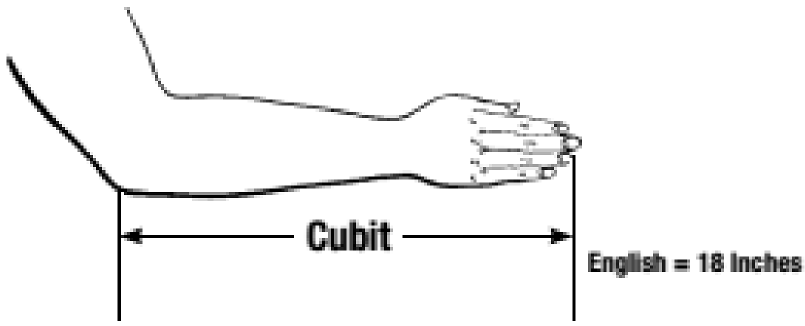
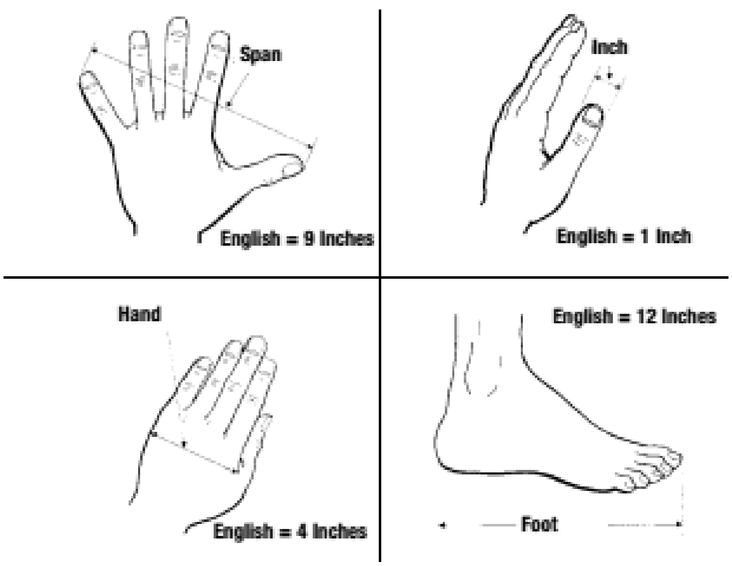


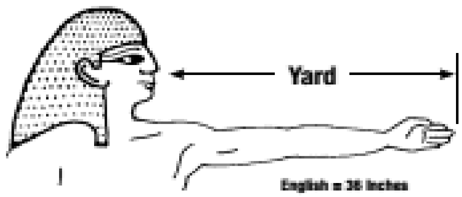
Fig 2.1

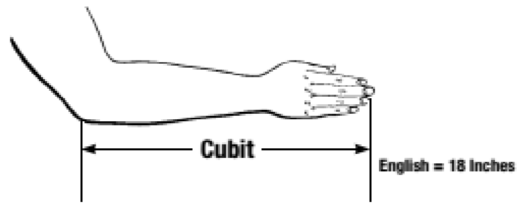


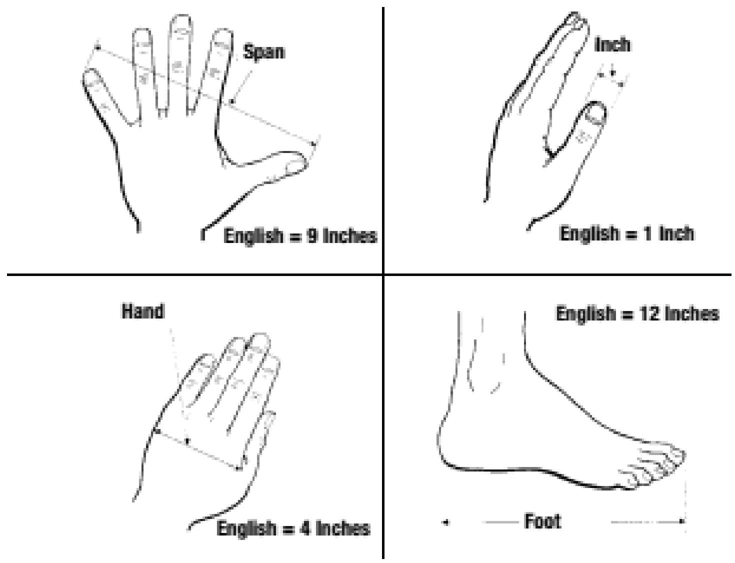


. **Using alternative measuring instruments**

Precision has not always been associated with measurement. At the dawn of civilization, man began to use parts of the body to estimate dimensions, from such measurements, there evolved the first standards of measurement: the inch, hand, span, foot, cubit, yard and fathom. The tools of the past did not demand great accuracy. Most products were custom made by hand and a fraction of an inch one way or the other made little difference to satisfactory operation.


Yard
English = 36 Inches


Cubit
English = 18 Inches


Span
English = 9 Inches
Inch
English = 1 Inch
Hand
English = 4 Inches
English = 12 Inches
Foot

Self-Check -2	Written Test

Match

A

1. Accuracy
2. Reproducibility
3. Sensitivity

B

A. the degree of the closeness to a repeatedly measured quantity
B. the ratio of the magnitude
C. the degree of the closeness to the true value

Answer Sheet

Name: ___________________________ Date: ________________

Short Answer Questions

1.

2.

3.

Score = ____________

Rating: _____________

***Note:* Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**.

Operation Sheet 1	Obtaining correct specifications

Techniques of measuring length

1. Select/identify/ the type of measuring instrument you use
2. Prepare different size of steel and/or conduits.
3. Measure 0.25m of conduit
4. Convert the measured unit in to cm
5. Mark the measured size.
6. Report your work and conclusion to your trainer

LAP Test. 1.	**Selecting measuring Instruments**

Instructions: Given necessary instrument and materials you are required to perform the following tasks within 1hour.

Information sheet 3	selecting measuring Instruments

.1. MEASURING INSTRUMENTS Measurement is the process or the result of determining the ratio of a physical quantity, such as a length, time, temperature, etc., to a unit of measurement, such as the meter, second or degree Celsius. The science of measurement is called metrology. The English word measurement originates from the Latin measure and the verb metric through the Middle French measure.

Electrical measuring tools and instruments are sensitive and delicate so extra care is necessary in handling them. These are used to measure currents, voltages, resistances, wattages and other important elements in electrical works. This topic, will tackle the function/use of each measuring tool and instrument used in doing a electrical task. Different kinds of measuring tools and precision measuring instruments are as follows:

Table 3.1. Description of measuring tool/instrument

Measuring tool/instrument	Description
 	Test Light is a pocket size tool used to test the line wire or circuit if there is current in it.
	Micrometer is used to measure the diameter of wires/conductors in circular mils. It can measure small and big sizes of wires and cables
	Wire Gauge is used in determining the size of wires/conductors. The gauge ranges from 0 to 60 awg (American wire gauge).
	Ruler/foot rule is a measuring tool used to measure length, width and thickness of short flat object and in sketching straight lines

	*A ruler/rule is a tool used in, for example, geometry, technical drawing, engineering, and carpentry, to measure lengths or distances or to draw straight lines. Strictly speaking, the ruler is the instrument used to rule straight lines and the calibrated instrument used for determining length called a measure. However, common usage calls both instruments rulers and the special name straight edge is used for an unmarked rule.
 	Pull-Push Rule is a measuring tool used to measure the length of an object in centimeter and inches
	Ammeter is an instrument used to measure the amount of electrical current intensity in a circuit. The unit of measure is ampere (a). It is connected along or series to the circuit.

	Voltmeter is an instrument used to measure electrical pressure or voltage of a circuit. The unit of measure is volt (v). This is connected across or parallel to the circuit.
	Clamp Ammeter is also called tong-tester. It is used to measure current flowing in a conductor. It is clamped or hanged in a conductor.
	Volt-Ohmmeter (VOM) otherwise called as Multi-tester; is used to measure the voltage, resistance and current of a circuit. It is connected in parallel or series with the circuit depending on what to measure.

Self-Check 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Say true and false for the following question below

1. Micrometer is used to measure the diameter of wires/conductors in circular mils.
2. Test Light is not a pocket size tool used to test the line wire
3 Measurement is the process or the result of determining the ratio of a physical quantity.
4. Wire Gauge is not used in determining the size of wires/conductors.

Answer Sheet

Name: _________________________ Date: _______________

Answer

1.___

2.___

3.___

4.___

Score = ___________

Rating: ____________

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**.

Instructions: Given necessary instrument and materials you are required to perform the following tasks within 1hour.

Task 1: The operator aware of the state of readiness of the equipment

Task2: Use appropriate tools for appropriate material maintenance and righs measuring instrument for right measurement.

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