Mineral Resources Infrastructure Work

Level –I

Based on December, 2018 Version 2 OS and April, 2021 V1 Curriculum

Module Title: - Carrying out Measurements and calculating Specifications

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Contents

LG #28	LO #1- Plan and prepare

Instruction Sheet

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

- Mining terminologies
- Communication devices
- Following organizational procedures
- Accessing, interpreting and applying compliance documentation
- Confirmation and application of work instructions
- Selection of measuring and calculating equipment
- Checking for serviceability of equipment
- Reporting and rectifying faults

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.

- access, interpret and apply Compliance documentation
- confirm and apply Work instructions
- select Measuring and calculating equipment
- Check for serviceability of equipment.
- Report and rectify faults.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 24.

3. Read the information written in the “Information Sheets 1,2,3,4,5,6,7 and 8”. 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” in page -5, “Self-check 2” in page -8, “Self-check 3” in page -10, “Self-check 4” in page -12 , “Self-check 5” in page -14, “Self-check 6” in page -17, “Self-check 7” in page -20, “Self-check 8” in page -22 .
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, Self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7, Self-check 8).
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.

Information Sheet 1 - Mining terminologies

1.1. Terminologies commonly used in Measurements and Calculations

Terminologies are the body of terms used with a particular technical application in a subject of study, profession.

Measurement is the assignment of a number to a characteristic of an object or event, which can be compared with other objects or events. The scope and application of measurement are dependent on the context and discipline.

Measurement in mining could be length, area, weight, height, width, depth, volume, mass, scales, perimeters, quantities, grade etc..

A **calculation** is a deliberate process that transforms one or more inputs into one or more results, with variable change. Calculation performed could be arithmetic operation such as addition, subtraction, multiplication, division; operation such as perimeter circumference, area, volume, number, ratio, percentage; conversions such as of meters to millimeters and millimeters to meters.

Glossary of the most common mining terms. There are four main mining methods:

- **Underground mining** which is used to reach deeper deposits
- **Open surface (pit) mining** used for more shallow and less valuable deposits.
- **Placer mining** used to sift out valuable metals from sediments in river channels, beach sands, or other environments. and
- **In-situ mining** which is primarily used in mining uranium, involves dissolving the mineral resource in place then processing it at the surface without moving rock from the ground.

The method used depends on the type of mineral resource that is mined, its location at or beneath the surface, and whether the resource is worth enough money to justify extracting it. Each mining method also has varying degrees of impact on the surrounding landscape and

environment. Accordingly, it is possible to find as many terms as possible on these four methods of mining. But the most common mining terms are

Bench: in an underground mine, this is the horizontal low ledge or floor on which material is quarried or worked on.

Beneficiation – any process that improves the value of ore by removing waste.

Blast hole: this is a hole drilled into a material due to be blasted, to contain the explosive charge.

Core or core sample: a sample of rock that has been drilled out of the potential mine area.

Diamond drill: a drill used to collect core samples from rock.

Deposit: an amount of ore or mineral that makes exploitation worthwhile.

Face drilling: – a method used in conventional mining to drill a hole in the coal bed for inserting explosive charges. The holes are drilled into the rock and packed with explosives.

Fine-grained; a material consisting of very small particles, each with an average size smaller than 1 mm in diameter.

Grade: the amount of mineral contained in a piece of ore.

Grind: to crush ore into grains or powder.

Hanging wall: the area above where the ore is present in a mine.

Metallurgy the art of working metals, especially extracting them from their ores.

Mine value chain: the entire mining process, from the moment the potential of an area is identified to the day product is delivered to customers.

Mine recovery: the percentage of mined ore that makes it to the processing plant.

Non-destructive testing: a way to measure the integrity of materials or structures, without causing any harm.

Outcrop: a place where a coal seam is exposed at the surface. Ore rock from which we can extract valuable minerals and metals.

Precious metal: rare naturally occurring metallic chemical elements regarded as investments or used in industry. Examples include gold, silver and the platinum group metals or PGMS: ruthenium, rhodium, palladium, osmium, iridium, and platinum.

Pre-feasibility: a detailed examination of the business case for mining in a particular location.

Processing: extracting metals and minerals from ore and then purifying them.

Process recovery: the percentage of product we can extract by processing.

Production: the amount of ore mined in a specific timescale.

Quartz: one of the most abundant minerals in the Earth's crust

Refine: to produce the pure state of a commodity from its ore.

Rehabilitation: leaving the mine area in the condition in which you find it or the condition agreed with the local community.

Reserve: resources of coal, ore or minerals which can be mined profitably under existing conditions.

Resource: a naturally occurring liquid, solid or gas in the earth's crust that can be extracted for profit.

Tailings: the material or waste left over after the valuable product/commodity has been extracted from ore.

Tailings dam: a dam used to store the waste byproducts or tailings produced during the process of extracting the valuable commodity/product from ore.

Vein: a fracture or crack in a rock that contains mineralized material.

Waste :rock that is mined but not processed.

Self-Check -1	Written Test

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

1. _____ is the assignment of a number to a characteristic of an object or event, which can be compared with other objects or events..(3 points)

   A. Measurement

   C. arithmetic operation

   B. conversions

   D. Services

2. ----------– is a sample of rock that has been drilled out of the potential mine area. (3 points)

   A. Core or core sample
   B. Vein
   C. Waste
   D. Metallurgy
   E. Mine value chain.

3. List out at least five calculation that could be performed.(5 points)

Note: Satisfactory rating above 6 points ***Unsatisfactory below 6 points***

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 2 -Communication devices

2.1. Communication devices

A communications device is any type of hardware capable of transmitting data, instructions, and information between a sending device and a receiving device.

Basically mining is a hazardous job involving lot of risks and series of challenges along with the huge investments for equipment and skilled manpower. So a reliable communication platform can reduce the gaps between the effective utilization of the equipment with zero accident potential and also helps in proper management of emergency situations.

2.2. classification of communication systems

2.2.1. Person(s) to Person(s)

Person to Person communication systems involving direct communication between person (person to person interview, person to person telephone calls).

Fig 1 person to person

2.2.2. Person to Machine

This type of communication is mainly required in case some danger is expected at the working place with the machine or surroundings.

.This type of situations is more prevailing in case of underground mining but whereas in opencast mining such type of situations is very rare and can be dealt easily

Fig 2 Person to Machine

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2.2.3. Machine to Persons

This type of communication used in which humans co works with artificial intelligence system and other machines as opposed to utilizing them as tools or devices.

The different type of systems covered under this are;

- conveyor alignment tracking
- conveyor belt scaling system
- In-Line Coal analysis system
- Pre indication of Maintenance of the equipment
- Block flow diagrams of different systems currently in operation,
- Security monitoring systems /Environmental monitoring system

Fig 3 machine to person

2.2.4. Machine to Machine

This is fully automated system where personal interference is very limited. Machine to machine systems is needed for effective control of emergency situations and managing the same. These systems includes

- Fire detection/protection system

- Emergency Response/Communication System
- Auto Inter locking between different equipment

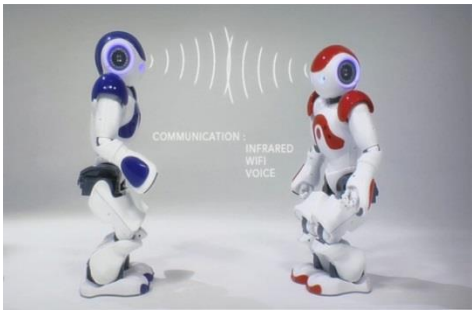


Fig 4 Machine to Machine

Self-Check -2	Written Test

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

1. Which one of the following is Person(s) to Person(s) communication systems (3 points)

C. Telephones

C. Conveyor alignment tracking

D. TDS D.

Conveyor belt scaling system

2. List classification of communication systems (3 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 3- Following organizational procedures

3.1. Organizational procedures

Procedure: is a particular way of doing something especially one that is usually repeated in the same way of each time.

Policies and procedures are an essential part of any organization. Together, policies and procedures provide a roadmap for day-to-day operations. They ensure compliance with laws and regulations, give guidance for decision-making, and streamline internal processes.

Procedures provide specific guidelines for completing a task, such as filling out and submitting a form. The procedures are normally based on organizational policy, which deals with broad issues, roles and functions relating to the specific area, such as case management, workplace safety or purchasing.

The areas covered in a procedure manual may include:

- Personnel practices (staff recruitment, training, holiday leave arrangements, promotions, performance appraisals, supervision)
- Complaints and disputes procedures
- Case management procedures (how the agency determines eligibility for the service, assesses client need and individual goal setting to address needs identified)
- Occupational health and safety procedures
- Conflict resolution processes
- Communication
- Delegations (who can make decisions about what, e.g. approval process for spending money)
- Notification of child abuse procedures
- Critical incidents procedures
- Confidentiality
- Referral

- Duty of care
- Coordination/ networking with external agencies.

Self-Check -3	Written Test

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

1) What is the difference between police and procedure?(point3)
2) List at least three areas that may be covered in a procedure manual? (3 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 4 -Accessing, interpreting and applying compliance documentation

4.1. Compliance documentation

Compliance documentation means specific documents or information including;

- legislative, organizational and site requirements and procedures
- manufacturer's guidelines and specifications
- Ethiopian standards
- code of practice
- Employment and workplace relations legislation
- Equal Employment Opportunity and Disability Discrimination legislation
- Records, reports, observations and verbal responses required to verify compliance with standards by a facility or program.
- **Accessing compliance documentation**
- Accessing compliance documentation is a means of approaching, entering, exiting, communicating with, or making use of different kinds of documents or information related to the work to be performed.
- **interpreting compliance documentation**
- Interpreting compliance documentation is explain the meaning of (information or actions) collected and accessed

- **applying compliance documentation**
- Applying compliance documentation is to make use of the above mentioned Accessing and interpreting specific documents or information for a practical purpose.

Self-Check -4	Written Test

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

1. List out three compliance documentation?(3 points)

2 The difference between accessing compliance documentation and interpreting compliance documentation? (3 point)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 5	Confirmation and application of work instructions

5.1. Work instructions

Work Instructions are also work guides documents that clearly and precisely describe the correct way to perform certain tasks that may cause inconvenience or damage if not done in the established manner. It describes a step by step guide to perform a single instruction. It contains more detail information than a Procedure and is only created if detailed step-by-step instructions are needed.

That is describing dictate or stipulate the steps that must be followed to correctly perform any specific activity or work.

5.2 Confirmation and application of work instructions

Confirmation of work instructions is an act of verifying or making certain that the documents clearly and precisely describe the correct way to perform certain tasks in the established manner.

Application of work instructions is the action of putting the above mentioned instructions into operation.

5.3 Accident prevention signs and tags

- **Danger sign**: Used where an immediate hazard exists

- **Caution sign:** Used to warn against potential hazards or to caution against unsafe practices

- **Safety instruction signs:** Used where there is a need for general instruction and suggestions relative to safety measures.

- **Accident prevention tags,** Used for temporary use only, to specify precautions and safety needs:

Danger tag: Placed only where an immediate hazard exists

- **Caution tag:** Used to warn against potential hazards or to caution against unsafe practices

- **Out of order tag:** used to identify pieces of or equipment that is out of order

Fig 2 Work Instructions template

Self-Check -5	**Written Test**

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

1. What is work instructions three points.(4 points)
2. List the Accident prevention signs and tags(4point)

Note: **Satisfactory rating – 4 points** **Unsatisfactory - below 4 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 6	Selection of measuring and calculating equipment

6.1. Measuring equipment / instruments

A measuring instrument is a device for measuring a physical quantity.

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 measuring tapes. Virtual instrumentation is widely used in the development of modern measuring instruments.

A range of field measuring tools ranging from robust measuring tapes made to be used in all weather conditions in the outdoors, to hardness & magnetic testing items including scriber's & swing pens. We also stock a range of mapping aids for surveyors & keen hill walkers as well as various scale rulers often used by surveyors.

Fig 6.1 measuring tapes

- Structural geologists (i.e. those concerned with geometry and the pattern of relative movement) also have a need to measure the plunge and plunge direction of lineation.

Some of the Measurement done could be length, area, weight, height, width, depth, volume, mass, scales, perimeters, quantities, numbers, grade of a physical quantity.

Fig 6.2 Brunton compass

6.2. Calculating equipment

A calculation is a deliberate process that transforms one or more inputs into one or more results, with variable change.

It could be arithmetic operations such as Addition, subtraction, multiplication and division or calculations to find the Length, perimeter, circumference, area, volume, number, ratio, percentage or calculations to make conversions, such as of meters to millimeters and millimeters to meters.

Fig 3.3 graphic calculator

Earlier there were many mechanical calculators before modern computers were invented such as Abacus, Pascal's Calculator, Stepped Reckoner, Arithmometer, Comptometer, The

Difference Engine, Analytical Engine, and the Millionaire. But now a day graphing calculators (Fig 6), spreadsheets and computer algebra systems ease the burden of calculation.

A computer algebra system (CAS) is any mathematical software with the ability to manipulate mathematical expressions in a way similar to the traditional manual computations of mathematicians and scientists.

Self-Check – 6	*Written Test*

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

1. Which one of the following is not measuring instrument (5 points)

   A. rulers C. electron microscopes

   B. stopwatches D. house

2. ---------- is any mathematical software with the ability to manipulate mathematical expressions in a way similar to the traditional manual computations of mathematicians and scientists. (5 points)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 7 -Checking for serviceability of equipment

7.1. Serviceability

Serviceability is the measure of and the set of the features that support the ease and speed of which corrective maintenance and preventive maintenance can be conducted on a system.

Preventive Maintenance (PM) includes all the actions taken to replace, service, upgrade, or patch a system to retain its operational or available state and prevent system failures

Corrective Maintenance (CM) includes all the actions taken to repair a failed system and get it back into an operating or available state. The failure can be unexpected or expected, but it is usually an unplanned outage.

7.2. Serviceability for Each Phase of Life

A product's life can be divided into four phases: Pre-Life, Early Life, Useful Life, and Wear Out. Each phase requires making different considerations to help avoid a failure at a critical or unexpected time because each phase is dominated by different concerns and failure mechanisms.

Phase 1: Pre-Life

The focus during Pre-Life is planning and design. The design and accessibility of a system can have the greatest impact on its serviceability. But to design appropriately, you must understand the level of serviceability you need for a system.

These are only some of the considerations you need to make. Such as Cost of downtime, Preventive maintenance, Sparing strategy, Diagnostic tool requirements, Operation and service skills, and Environmental factors.

Phase 2: Early Life

Early Life is typically characterized by a failure rate higher than that seen in the Useful Life phase. These failures are commonly referred to as "infant mortality." Such early failures can be accelerated and exposed by a process called Burn In, which is typically implemented prior

to system deployment. The higher failure rate is often attributed to manufacturing flaws, bad components not found during manufacturing test, or damages during shipping, storage, or installation. The failure rate rapidly decreases as these issues are worked out.

Phase 3: Useful Life

Useful Life is when the system's Early Life issues have been worked out and it is trusted for normal operation. During this phase, many of the rigorous scientific and mathematic concepts of rams' engineering are applied. In Useful Life, failures are considered to be "random chance failures," and they typically yield a constant failure rate. This is fortunate because a constant failure rate simplifies the mathematics associated with predicting failures.

Phase 4: Wear Out

The Wear Out phase begins when the system's failure rate starts to rise above the "norm" seen in the Useful Life phase. This increasing failure rate is due primarily to expected part wear out. Usually mechanical moving parts such as fans, hard drives, switches, relays, and frequently used connectors are the first to fail. However, electrical components such as batteries, capacitors, and solid-state drives can be the first to fail as well. Most ICs and electronic components last about 20 years [9] under normal use within their specifications.

During the Wear Out phase, a system's reliability is compromised and difficult to predict since it no longer exhibits a constant failure rate). Therefore, rigorous PM and replacement plans are advised. High serviceability features and practices can significantly lower the cost and downtime associated with replacing and upgrading systems during their Wear Out phase.

Self-Check – 7	Written Test

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

1. In which of the following Phase failures are considered to be “random chance failures,” and they typically yield a constant failure rate?(3 points)

   A. hase 3: Useful Life

   B. Phase 1: Pre-Life

   C. Phase 2: Early Life

   D. PhaseP4: Wear Out

2. What is Serviceability? (5 points)

Note: **Satisfactory rating – 3 and 5 points** **Unsatisfactory - below 3 and 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 8 -Reporting and rectifying faults

8.1. Fault Reporting

'Fault Reporting is a maintenance concept that increases operational availability and that reduces operating cost through three mechanisms.

- Reduce labor-intensive diagnostic evaluation
- Eliminate diagnostic testing down-time
- Provide notification to management for degraded operation

8.2. Rectifying faults

To diagnose and find faults is probably one of the most difficult tasks undertaken. To rectify faults is to correct installation, piece of equipment or make something right. The knowledge of fault finding and the diagnosis of faults can never be completely learned because no two fault situations are exactly the same. As the systems we install become more complex, then the faults developed on these systems become more complicated to solve. To be successful the individual must have a thorough knowledge of the installation or piece of equipment and have a broad range of the skills and competences associated.

The ideal person will tackle the problem using a reasoned and logical approach, recognize his own limitations and seek help and guidance where necessary.

If possible, fault finding should be planned ahead to avoid inconvenience to other workers and to avoid disruption of the normal working routine. However, a faulty piece of equipment or a fault in the installation is not normally a planned event and usually occurs at the most inconvenient time.

Self-Check – 8	Written test

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

1. What does rectifying faults mean? (3 points)

2. Mention the general steps to diagnose and rectify faults (5 points)

Note: **Satisfactory rating above 4 points unsatisfactory rating below 4 points.**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1 -Reporting and rectifying faults

8.3. General Steps to diagnose and rectify faults

1) Collect and Analyze the Evidence. All the evidence collected must be relevant to the problem in hand.
2) Identify and Locate the problem/ Fault.
3) Establish a theory of probable cause.
4) Test the theory to determine cause.
5) Establish a plan of action to resolve the problem.
6) Rectification of the Fault
7) Verify full system functionality and if applicable implement preventative measures.
8) Document findings, actions, and outcomes.

How to Fix Your Tape-Measure Retraction System

Step 1: open the Case. Use a small screwdriver to open the case.

Step 2: Look Inside. Take a look inside the case to see if there is a simple problem with the retraction system.

Step 3: Remove the Tape.

Step 4: Replace or Fix the Retraction System.

Step 5: Put the Tape Back.

Step 6: Closes the Case**.**

LG #29	LO #2- Perform measurements

instruction Sheet

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

- Following work procedures
- Applying selected measurements method
- Measuring using a ruler or tape
- Confirming and recording measurements

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 –

- apply selected method of the measurement
- obtain measurements using a ruler or tape accurate to 1mm
- confirm and record measurements

Information Sheet-1	Following work procedures

1.1. Workplace procedures

Work practices are generally written methods that define how tasks are performed while minimizing risks to people, equipment, materials, environment, and processes. Work Procedures are documented procedures for performing tasks.

1.2. purpose of Workplace procedures

Safe Work Procedures are documented procedures for performing tasks. The purpose of a work procedure is to reduce the risk to health and safety in the workplace and reduce the likelihood of an injury by ensuring that employees know how to work safely when carrying out the tasks involved in their jobs.

1.3 Types of Workplace procedures

- **Handling chemicals**: these involve procedures on how to handle chemicals in workplace where these are used.
- **Lifting and moving objects**: are procedures that pertain to how objects are to be lifted and moved safely and without strain to the person or worker.
- **Working at heights**: these are procedures that underscore what a worker must observe to keep himself safe while working in an elevated structure or environment.
- **Slips, trips and falls**: are procedures that pertain to safety procedures that should be in place to prevent slips, trips and fall accidents in the workplace.
- **Housekeeping**: are procedures that pertain to how housekeeping activities should be done while keeping in mind safety, health and well-being of workers in a facility or workplace.
- **Electrical equipment**: these are safety procedures that pertain to the installation, repair and maintenance of electrical equipment.

1.3. Components or elements of Workplace procedures and instructions.

The following steps should be followed to ensure a sound safe work procedure is developed:

Observe the task/activities: it is important to observe the task/activity being performed the preferred way to ensure safest method is documented.

Review associated legislative requirements: Some task/activities are governed by legislative requirements. These must be considered when developing a safe work procedure to ensure any legal requirements are included.

Record the sequence of basic job steps: write down the steps that make up the task/activity.

Record potential hazards of each step: Next to each step identify what may have potential to cause injury or disease

Identify ways of eliminating and controlling the hazards: list the measures that need to be put in place to eliminate or control any likely risk.

Test the procedure: Observe staff/student following the safe work procedure

Obtain approval: Before the safe work procedure can be used it must be approved by each approver nominated.

Monitor and review: Make sure the activity is supervised to ensure the documented process is being followed.

Self-Check -1	Written Test

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

1. Which of the following is components or elements of Workplace procedures (3 points)
   A. Observe the task/activities
   B. Review associated legislative requirements
   C. Test the procedure
   D. All of the above
2. What are Workplace procedures?(3 point)
3. ----------– are procedures that pertain to how housekeeping activities should be done while keeping in mind safety, health and well-being of workers in a facility or workplace ?(2 point)

Note: Satisfactory rating above 4 points ***Unsatisfactory below 4 points***

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Applying selected measurements method

2.1 measurements

Measurement is the way toward allotting numbers or marks to people, items, or occasions, as per specific rules for speaking to amounts or characteristics of qualities.

Measurement process is a method used to allot numbers that reflect the measure of a quality controlled by a man, article, or occasion.

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

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 interval scale** is defined as a quantitative measurement scale where the difference between 2 variables is meaningful. Interval scale is the 3rd level of measurement. In other words, the variables are measured in actuals and not as a relative manner, where the presence of zero is arbitrary.
- **Measurement method** is the technique or process used to obtain data describing the factors of a process or the quality of the output of the process.
- **Accuracy** is the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard
- **The measuring range** is the range of measured values for a measure and in which defined, agreed, or guaranteed error limits are not exceeded. It is delimited by a lower and an upper measuring range limit that define the measuring span. Measured values are used in metrology

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.

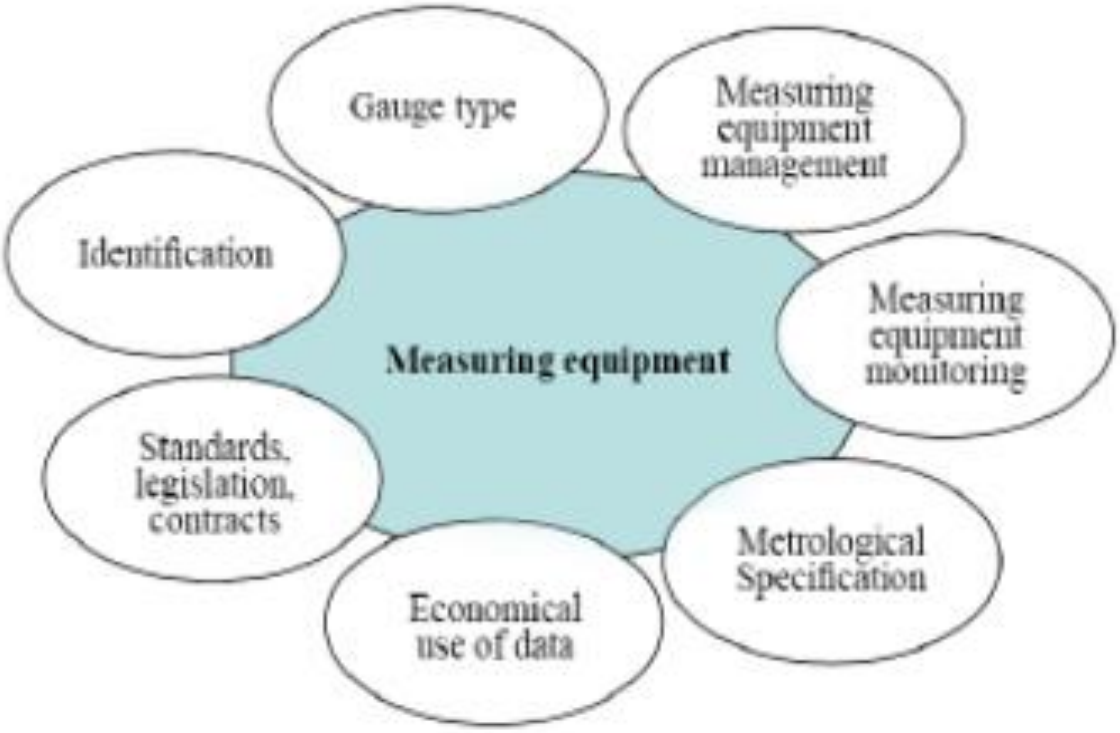


Fig 2.1 the exploitation and the economic indices

Self-Check -2	Written Test

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

1. _____ are metrological indices (3 points)
   - A. Scale interval
   - **B.** measurement method
   - **C.** accuracy
   - D. all of the above
2. _____ is the technique or process used to obtain data describing the factors of a process or the quality of the output of the process.(3 point)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Measuring using a ruler or tape

3.1 Measuring tools

A ruler or tape: - A tape measure or measuring tape is a flexible ruler and used to measure distance. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear-measurement markings. It is a common measuring tool.

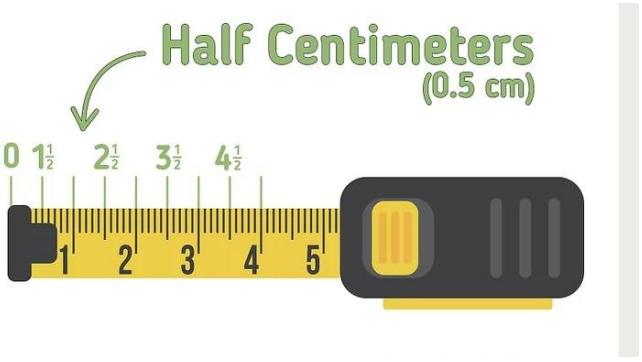
Fig 3.1 A Ruler or tape

Reading/ Measuring by metric Units

1. Use the big numbered markings for centimeters. On most metric measuring tapes, centimeters are the most prominent markings. Centimeters are usually labeled with large lines and, next to each line, a number.

markings for centimetres

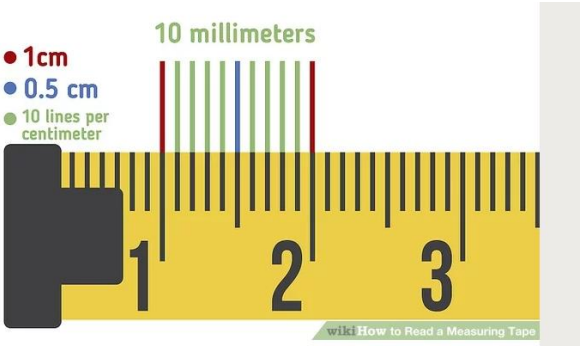
2. Use the smaller markings between centimeters for 0.5 centimeters. Some (but not all) metric measuring tapes will have medium-sized marks evenly spaced between each centimeter mark. These mark half-centimeters. These marks are usually not labeled with a number



markings between centimetres

3. Use the small, densely-packed markings for millimeters. The small, tight, narrow lines between centimeter markings represent millimeters (or one-tenth-centimeters). There are ten millimeters in a centimeter (and, thus, one thousand in a meter.)
4. Add the centimeter segments to determine the total length.

   To measure with a metric measuring tape, first find the nearest centimeter before the distance you're measuring, then the nearest millimeter. You can use a 0.5 millimeter mark to help guide you if your measuring tape has them. Your measurement (in centimeters) will be a decimal where the tenths place is indicated by the millimeter marking.



markings for millimetres

Self-Check -3	Written Test

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

1. What do we mean by a ruler or tape (4 points)

Note: Satisfactory rating above 2 points ***Unsatisfactory below 2 points***

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Confirming and recording measurements

4.1 Confirming measurements

A confirmation generally provides proof that something is true. It is verification or final proof of something. Confirming measurements is to verify the measurements made by the ruler, tape or other measuring instrument mentioned above is true.

4.2 Recording measurements

Recording measurements is to put measurements taken by the above mentioned measuring instrument into a form in which it can be kept.

Accordingly, Confirming and recording measurements is to provide proof that our measurement is true and put it into a form in which it can be kept.

Self-Check -4	Written Test

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

1. What do we mean when we say confirming and recording measurements? (4 points)

Note: Satisfactory rating above 2 points ***Unsatisfactory rating below 2 points***

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1	Measuring using a ruler or tape

Taking a Measurement

1.1. The Steps for taking a Measurement are;

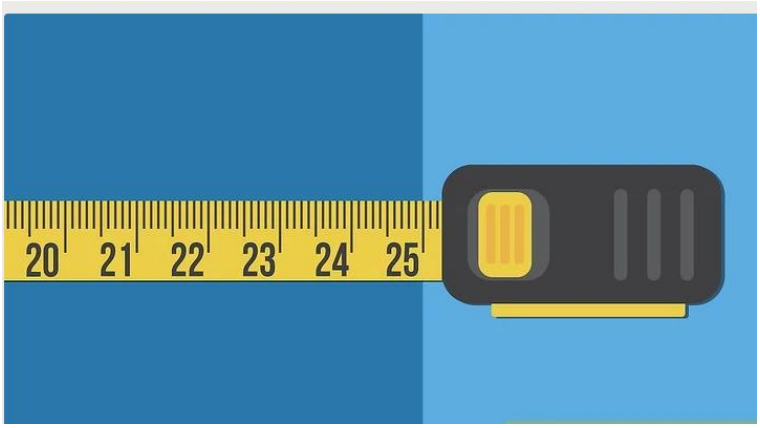
1st. Catch the hooked end on one side of the object you're measuring.

Catch the hooked end on one side

2nd. Stretch the tape across your object.

Stretch the tape

3rd. Take a reading directly from the tape.



Take a reading

4th. Use the lock switch to keep the tape at the same length.

Use the lock switch to keep the tape

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1- Determine actions/requirements to take Measurement by using a ruler or tape

LG #30	LO 3#- Perform calculations

Instruction sheet

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

- Following organizational procedures and requirements
- Selecting appropriate calculation method to achieve the required result
- Conversion of physical quantities
- Calculating material quantities correctly
- Confirming and recording results in the standard format

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 calculation method for achieving the required result
- Calculate material quantities correctly
- confirm and record results in standard format

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 43 to 56.
3. Read the information written in the “Information Sheets 1,2,3,4 and 5”. 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” in page – 43, “Self-check 2” in page – 46, “Self-check 3” in page – 51, “Self-check 4” in page – 53, “Self-check 5” in page - 55.

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.

Information Sheet-1	Following organizational procedures and requirements

1.1. Organizational procedures

Procedures provide specific guidelines for completing a task, such as filling out and submitting a form. The procedures are normally based on organizational policy, which deals with broad issues, roles and functions relating to the specific area, such as case management, workplace safety or purchasing.

Procedures provide employees with a clear understanding of what is expected of them. Procedures provide a fair, predictable and consistent approach to managing the workplace and workplace issues such as what kind of calculation method should be used to achieve the required result

1.2. organizational requirements

Every organization has plans and requirements that determine how it will progress into the future. The strategic planners and management of the organization, in consultation with staff, determine most of these requirements. Others are externally imposed, such as the legislation the organization is required to comply with.

Some examples of organizational requirements are:

- the organization's vision, goals, objectives and priorities
- business and performance plans
- systems, processes and requirements for quality assurance
- specific change initiatives
- legal requirements, for example, occupational health and safety and anti-discrimination legislation
- standards (such as for ethical behavior) and protocols

- confidentiality and security requirements
- Defined resource parameters.

Self-Check -1	Written Test

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

1. _____ provide specific guidelines for completing a task, such as filling out and submitting a form (2.point)

2. What is organizational requirement? List examples of organizational requirements are (4 point)?

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

.

Answer Sheet

Score = _____

Rating: _____

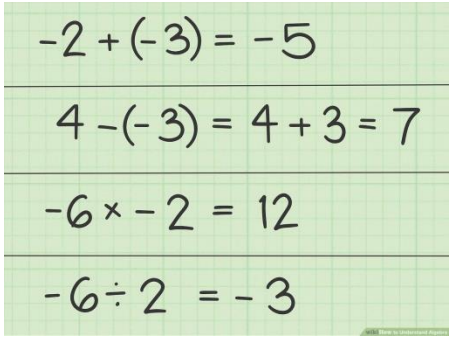
Name: _____ Date: _____

Information Sheet-2	Selecting appropriate calculation method to achieve the required result

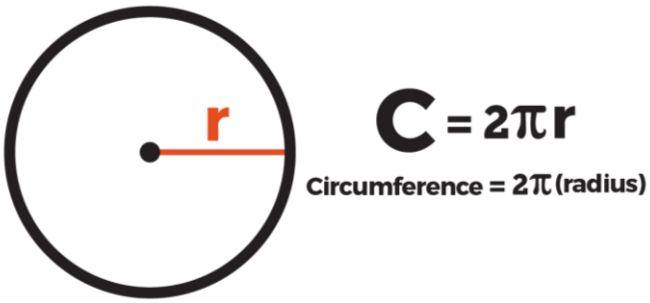
A calculation is a deliberate process that transforms one or more inputs into one or more results, with variable change.

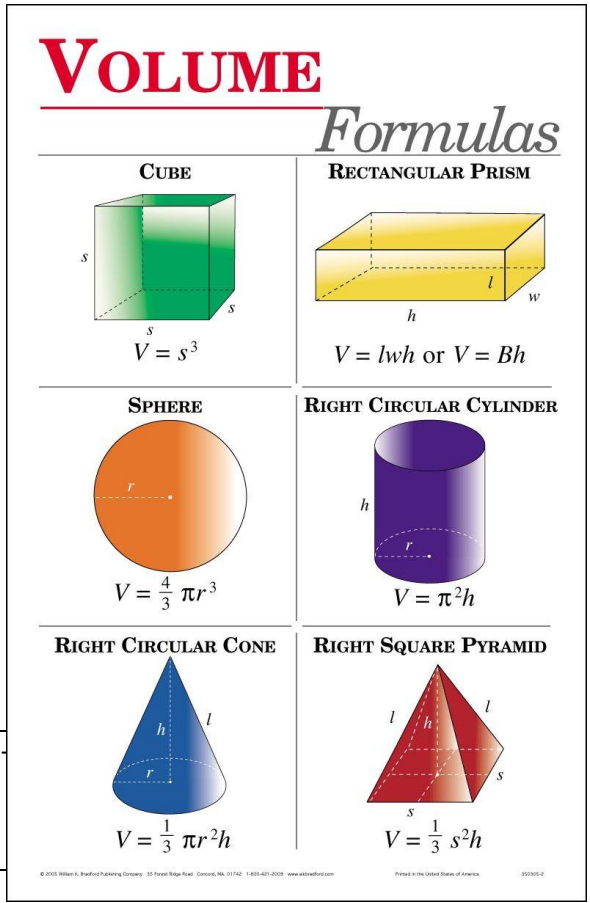
Calculation method performed could be

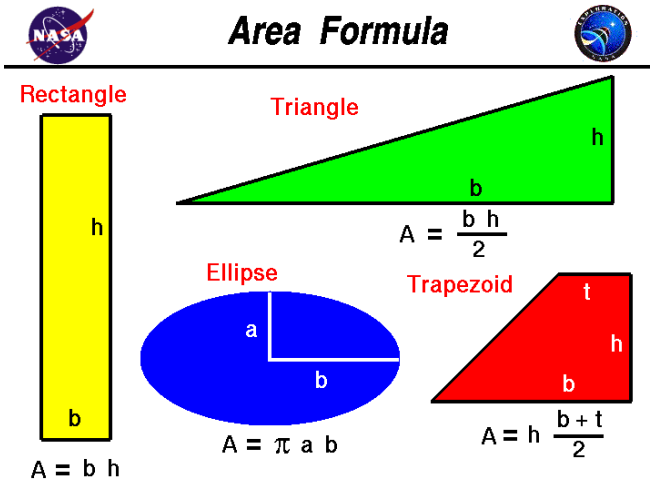
- **arithmetic operation** such as addition, subtraction, multiplication, division;



- **Operation** such as perimeter circumference, area, volume, number, ratio, percentage.







Circumference, area, volume

- **Conversions** such as of meters to millimeters and millimeters to meters. meters to centimeters

Meter to Millimeter Conversion Table

Meter to Centimeter Conversion Table

Meter [m]	Millimeter [mm]
0.01 m	10 mm
0.1 m	100 mm
1 m	1000 mm
2 m	2000 mm
3 m	3000 mm
5 m	5000 mm
10 m	10000 mm
20 m	20000 mm
50 m	50000 mm
100 m	100000 mm
1000 m	1000000 mm

Meter [m]	Centimeter [cm]
0.01 m	1 cm
0.1 m	10 cm
1 m	100 cm
2 m	200 cm
3 m	300 cm
5 m	500 cm
10 m	1000 cm
20 m	2000 cm
50 m	5000 cm
100 m	10000 cm
1000 m	100000 cm

Self-Check -2	Written Test

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

1. A _____ is a deliberate process that transforms one or more inputs into one or more results, with variable change (5 points).

2. convert 15 meter to centimeter: (5 points)

Note: Satisfactory rating - 5 points ***Unsatisfactory - below 5 points***

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Conversion of physical quantities

3.1. System of measurements

The two (2) systems of measurements are: the English and the Metric System. The English system originated in England also known as the U.S. customary system of measurement while the Metric System was developed in France and also known as the S. I. (International Standard).

3.1.1. SI System

The International System of Units (abbreviated SI from French: System international d'unités) is the modern form of the metric system and is generally a system of units of measurement devised around seven base units and the convenience of the number ten.

3.2. Base Units in the SI System

Physical Quantity	Name of the Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Electric current	Ampere	A
Luminous intensity	Candela	cd
Amount of substance	Mole	Mol

Prefix	Symbol	Fraction/Multiple
Atto	A	10^{-18} <> ÷ 1 000 000 000 000 000 000
Femto	F	10^{-15} <> ÷ 1 000 000 000 000 000
Pico	P	10^{-12} <> ÷ 1 000 000 000 000
Nano	N	10^{-9} <> ÷ 1 000 000 000
Micro	M	10^{-6} <> ÷ 1 000 000
Milli	M	10^{-3} <> ÷ 1 000
Centi	C	10^{-2} <> ÷ 100
Deci	D	10^{-1} <> ÷ 10

Prefix	Symbol	Fraction/Multiple
-	-	$10^0 = 1$
Deca	Da	10^1 <> x 10
Hecto	H	10^2 <> x 100
Kilo	K	10^3 <> x 1 000
Mega	M	10^6 <> x 1 000 000
Giga	G	10^9 <> x 1 000 000 000
Tera	T	10^{12} <> x 1 000 000 000 000
Peta	P	10^{15} <> x 1 000 000 000 000 000
Exa	E	10^{18} <> x 1 000 000 000 000 000 000

3.3. Derived Quantities and Units

Quantity	Formula	Symbol (SI Unit)
Area	A=LxB	m x m = m^2
Volume	V=LxBXH	m x m x m = m^3
Density	D = Mass/Volume	kg / m^3 = kgm^{-3}
Velocity	V = Distance/Time	m / s = ms^{-1}
Acceleration	a = Change in Velocity/Time	ms^{-1}/s = ms^{-2}
Momentum	p = mass x velocity	kg x ms^{-1} = $kgms^{-1}$
Force	F = Mass x Acceleration	kg x ms^{-2} = $kgms^{-2}$ = N(newton)
Work	W = Force x Distance	N x m = J(joule)
Power	P = Work / Time	J / s = Js^{-1} = W (watt)
Potential Energy	P.E. = Force x Displacement = m x g x h	N x m = kg x ms^{-2} x m = kgm^2s^{-2} = J(joule)
Kinetic Energy	KE. = (1/2) x mass x $(Velocity)^2$	kg x ms^{-1} x ms^{-1} = kgm^2s^{-2} = J (joule)
Moment of Force	Moment = Force x Perpendicular Distance	N x m = Nm
Pressure	P = Force / Area	N/m^2 = Nm^{-2} or Pa(Pascal)

3.4. Converting units of measure

Conversion of Units is a multi-step process that converts units of measurement for the same quantity. It includes division or multiplication by a numerical factor or rounding off the significant digits.

These are important because the units are used in various places such as the commercial marketplace, technical documents, temperature, and for other specifications. A common conversion table states the length, volume, mass, and area.

The units are expressed by using scientific notation and converted into numerical values as per the quantities

GUIDE TABLE IN UNIT CONVERSION

English	to	English	1foot	=	12 inches
Metric	to	Metric	1 meter	=	10 decimeter
			1 dm	=	10 centimeter
English	to	Metric	1 inch	=	2.54 cm
			1 inch	=	25.4 mm
			1 foot	=	30.48 cm
Metric	to	English	1 meter	=	3.28 feet
			1 meter	=	39.37 inches

Sample Solutions in Conversion

A. Foot to inches

3 ft = _____ inches

Solution: Multiply 3ft by 12 inches / ft = 36 inches

B. Inch to feet

48 inches = _____ Feet

Solution: Divide 48 inches by 12 inches / feet = 4feet

C. Centimeter to millimeter

22 cm = _____ millimeters

Solution: Multiply 22 cm by 10 mm / cm = 220mm

D. Inch to centimeter

6 inches = _____ centimeter

Solution: Multiply 6 inches by 2.54 cm / inch = 15.24 cm

When converting between units the idea is to position the units in such a way that we 'cancel' out the old units and 'state' the new units

Conversion where at least 1 of the units is a base unit

Method

Example 1 - Convert 1.25 cm to m

|_____|Conversion to new unit

Step 1: State units |

V

1.25 cm = 1.25 cm x _____ _ m

| cm

| /\

|_____| Conversion from old unit

Step 2: Insert '1' for the larger unit

1.25 cm = 1.25 cm x ___1 __m

cm

Step 3: Insert the multiple between the 2 units

1.25 cm = 1.25 cm x ___1 x __m

100 cm

Step 4: Calculate

1.25 cm = 1.25 ~~cm~~ x ___1 x __m

100 ~~cm~~

= 0.0125 m

Self-Check -3	Written Test

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

1. Mention at least three Base Units in the SI System (3 points)

2. What is Conversion of Units? (3 points)

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

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Calculating material quantities correctly

4.1 Basic Functions of Material Quantity Calculation

In material requirements planning and product costing, material quantity calculation is used to calculate the material and operation quantities that are, for example, necessary for reservations or direct cost statements. In the process order, material quantity calculation determines the order-specific quantities.

Self-Check -4	Written Test

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

1. What is the basic Functions of Material Quantity Calculation? (6 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Confirming and recording results in the standard format

Confirming results

A confirmation generally provides proof that something is true. It is verification or final proof of something. Confirming results is to verify the results we gate by using the calculation method done above is true.

Recording results

Recording results is to put results we gate from the calculation method done above which it can be kept.

Accordingly, Confirming and recording result is to provide proof that our measurement and calculation result is true and put it into a form in which it can be kept.

Self-Check -5	Written Test

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

1. What do we mean when we say Confirming and recording result (4 point)?

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

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

LG #31	LO #4- Estimate approximate quantities

Instruction sheet

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

- Taking calculations to determine material requirements
- Selecting appropriate formulas to calculate quantities
- Estimating approximate quantities from the calculations taken
- Understanding enterprise tolerances
- Calculating, confirming and recording material quantities

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 –

- Take calculations for determining material requirements
- Select appropriate formulas for calculating quantities
- estimate estimated Quantities from the calculations taken
- calculate, confirms and record material quantities for the project requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 59 to 71.
3. Read the information written in the “Information Sheets 1,2,3,4 and 5”. 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” in page - 60, “Self-check 2” in page - 64,Self-check 3” in page - 66, “Self-check 4” in page - 68, “Self-check 5” in page 70 -.

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.

Information Sheet-1	Taking calculations to determine material requirements

The most important determining factors whether surface mining done are economic and technical.

- ✓ the price for the product,
- ✓ the cost of production,
- ✓ the quality and quantity of the deposit,
- ✓ the volume of overburden to be removed per ton of the deposit, and
- ✓ The feasibility of reclamation.

Material requirements planning (MRP) is a system for calculating the materials and components needed.

It consists of three primary steps:

- taking inventory of the materials and components on hand,
- identifying which additional ones are needed and
- Scheduling their production or purchase.

Self-Check -1	Written Test

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

1. List The most important determining factors whether surface mining done are economic and technical (4 point)?

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

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Selecting appropriate formulas to calculate quantities

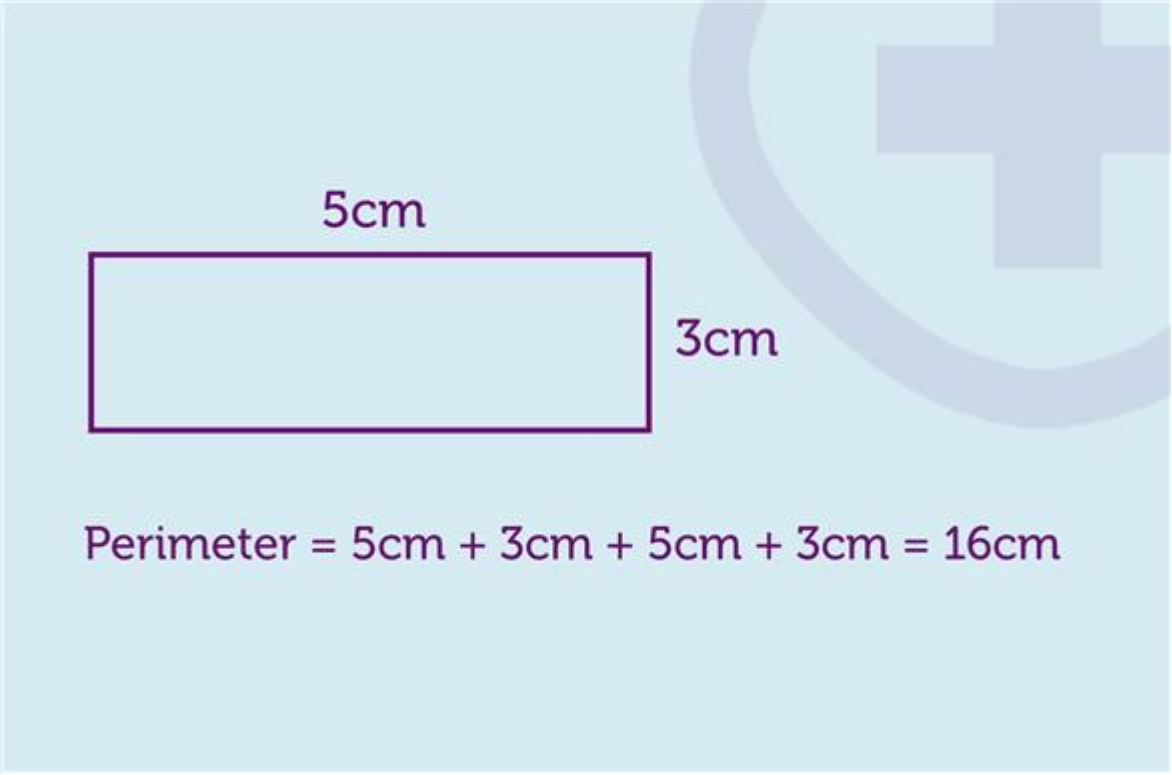
2.1. Formulas to calculate quantities

As we have discussed earlier the quantities to be discussed here are length, perimeter, circumference, area, volume, number, ratio, and percentage of the material. You may be required to solve various problems involving perimeter, area and volume. The specific questions you will be expected to answer will vary depending upon problem, but as a rule you will be required to:

- Calculate the perimeter of various shapes
- Calculate the area of various shapes
- Calculate the volume of various shapes

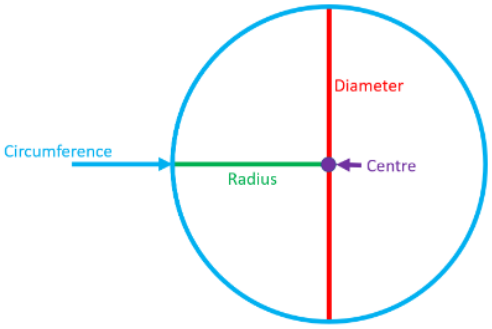
Perimeter

The 'perimeter' of a shape is the distance around it. In order to calculate the perimeter of a shape, you must add up the lengths of all its sides. For example, if a rectangle has a width of 5cm and a length of 3cm, its perimeter would be



Circumference

Circumference is the distance around the perimeter of a circle. It is calculated by multiplying the distance across the center (diameter) by Pi (3.14). Which we usually write in the shortened form C = πd.



Example 1

A circle has a diameter of 10cm, what is its circumference?

Answer

We know that C = πd. Since the diameter is 10cm, we have that C = π x 10cm = 31.42cm (to 2 decimal places).

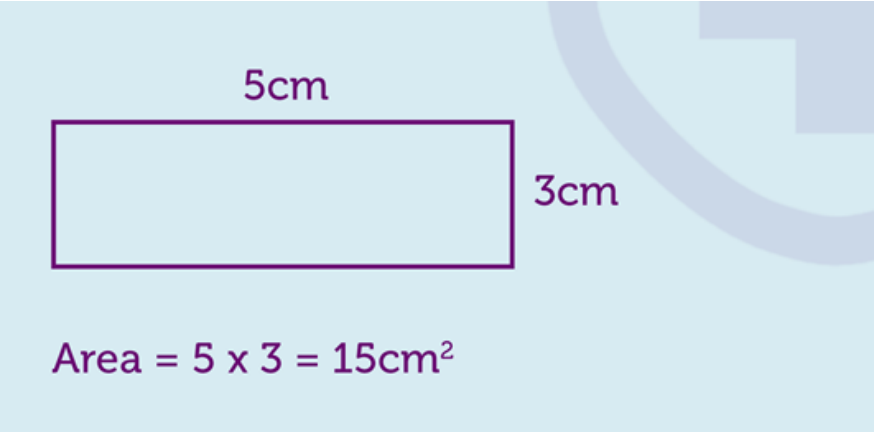
Area

The '**area**' of a shape is the number of square units which cover it, i.e. the size of the surface of a shape.

Due to the fact that the area of a shape is calculated by multiplying a shape's length by its width, it is measured in '**square units**' .For example, the area of a square which is 1 meter on each side is 1 meter x 1 meter = 1 square meter or m2.

Other examples of square units include: millimeters squared (mm2) and centimeters squared (cm2).

For example, if a rectangle has a width of 5cm and a length of 3cm, its area would be:



There are several shapes which follow simple area formulae:

The area of a triangle = 1/2 x base x height

The area of a rectangle = base x height

The area of a parallelogram = base × height

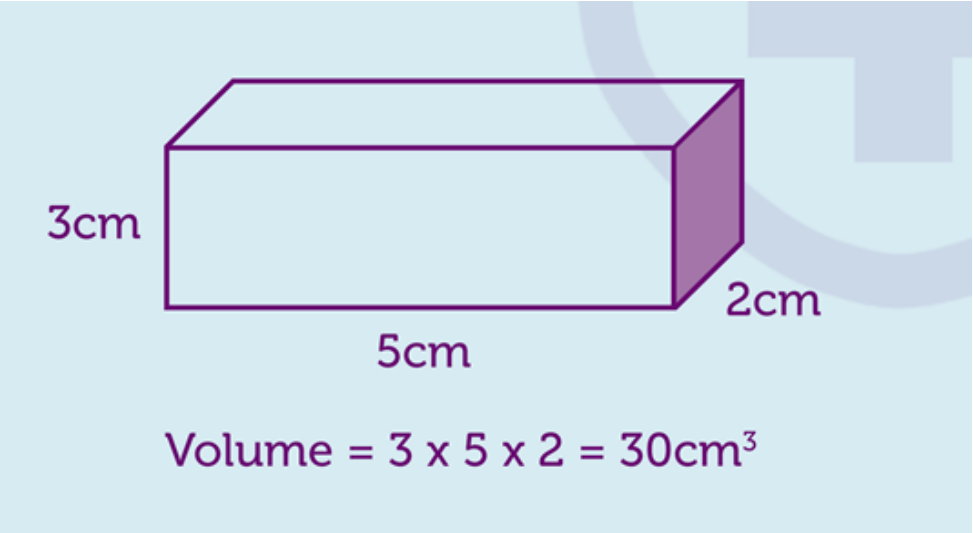
Volume

The 'volume' of a shape is the number of cubic units which occupy it, i.e. the amount of 3D space which the shape occupies.

Due to the fact that the volume of a shape is calculated by multiplying a shape's length by its width by its depth, it is measured in 'cubic units'. For example, the volume of a square which is 1 meter in length, 1 meter in width and 1 meter in depth is 1 meter x 1 meter x 1metre = 1 cubic meter or m3.

Other examples of cubic units include: millimeters cubed (mm3) and centimeters cubed (cm3).

For example, if a cuboid has a width of 5cm, a length of 3cm and a depth of 2cm, its volume would be:


3cm
2cm
5cm
Volume = 3 x 5 x 2 = 30cm³

Self-Check -2	Written Test

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

1. Calculate volume of cuboid body of width 10cm, a length of 7cm and a depth of 5cm, (***6 points)***

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

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Estimating approximate quantities from the calculations taken

3.1 estimation; an estimate is a calculation of the quantities of various items of work, and the expenses likely to be incurred thereon.

An estimate is necessary to give the owner a reasonably accurate idea of the cost to help him decide whether the works can be undertaken as proposed or needs to be curtailed or abandoned, depending upon the availability of funds and prospective direct and indirect benefits.

Estimating Materials for example is the estimate of a work to determine what materials and in what quantities will be required for the works so that the arrangements to procure them can be made.

An approximate estimate is an approximate or rough estimate prepared to obtain an approximate cost in a short time

In order to prepare an estimate the estimator must have the data on:

- Plans, sections and other relevant details of the work.
- Specifications indicating the exact nature and class of materials to be used.
- The rates at which the different items of work are carried out.

Self-Check -3	Written Test

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

1. What is an estimate? (4 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Understanding enterprise tolerances

Enterprise is another word for a for-profit business or company, but it is most often associated with entrepreneurial ventures. Ultimately, the word enterprise is a synonym for business. People who have entrepreneurial success are often referred to as “enterprising.” There are many forms of legal enterprises, i.e. Partnership, Corporation, Limited Liability Company (LLC) etc.

General tolerance sets are defined by specifying pairs of values that determine the range of dimension values taking specific plus/minus tolerances.

A tolerance is an acceptable amount of dimensional variation that will still allow an object to function correctly.

Tolerances in construction are generally a variation in a dimension, construction limit, or physical characteristic of a material. They are a practical variation related to the function of the material or finished work and commonly accepted standards of the construction industry.

Accordingly an enterprise tolerance dictates an acceptable and allowable variation with in an enterprise activity.

Self-Check -4	Written Test

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

1. What is Tolerances? (3 points)
2. What is an Enterprise? (5 points)

Note: Satisfactory rating – 4 points ***Unsatisfactory - below 4 points***

.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	Calculating, confirming and recording material quantities

Confirming material quantities

A confirmation generally provides proof that something is true. It is verification or final proof of something. Confirming material quantities is to verify the material quantities taken and calculate above is true.

Recording material quantities

Recording material quantities is to put material quantities taken by the above mentioned method into a form in which it can be kept.

Accordingly, Confirming and recording material quantities is to provide proof that our material quantities is true and put it into a form in which it can be kept

Self-Check -5	Written Test

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

1. What is recording material quantities (2 points?)

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

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

List of Reference Materials

- https://searcherp.techtarget.com/definition/material-requirements-planning-MRP
- https://www.mathsdoctor.co.uk/revision-help/gcse/geometry-and-measures/perimeter-area-and-volume/
- https://www.misronet.com/estimating.htm#data
- https://www.shopify.com/encyclopedia/enterprise
- https://help.sap.com/doc/saphelp_me151/15.1.3VERSIONFORSAPME/en-US/5b/84bf53f106b44ce10000000a174cb4/content.htm?no_cache=true
- https://www.ni.com/en-za/innovations/white-papers/13/what-is-serviceability-.html
- https://en.wikipedia.org
- https://www.youtube.com/watch?v=Ioo4a2-9NI0
- https://sielearning.tafensw.edu.au/MCS/CHCAOD402A/chcaod402a_csw/knowledge/policies/policies.htm
- https://dictionary.cambridge.org/dictionary/english/applying
- https://www.slideshare.net/venkoos/mine-communication-sysetms
- https://finfeed.com/investor-101/glossary-most-common-mining-terms/
- https://www.doityourself.com/stry/how-to-fix-your-tape-measure-retraction-system
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- https://www.skillmaker.edu.au/workplace-safety-procedures-and-instructions/
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- 17, https://www.wikihow.com/Read-a-Measuring-Tape#/Image:Read-a-Measuring-Tape-Step-7-Version-5.jpg

Acknowledgement

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The trainers who developed the training materials

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