Agricultural TVET College

Small Scale Irrigation Development

Level I

Model TTLM

Learning Guide -#12

Unit of Competence: Perform Basic Measurement and Calculation

Module Title: Performing Basic Measurement and Calculation

LG Code: AGR SSI1 M12 LO_1-LO_3

TTLM Code: AGR SSI1 TTLM 1218v2

Nominal Duration: 30 Hours

Instruction sheet	Learning guide #12

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

- ✓ Prepare materials, tools and equipment for measurements
- ✓ Perform simple measurement techniques
- ✓ Work with hand held global positioning system(GPS)

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 and check suitable personal protective equipment for male and female
- ✓ Identify suitable materials, tools and equipment.
- ✓ Conduct checkup on all materials, tools and equipment.
- ✓ Identify and report occupational health and safety hazards
- ✓ Use techniques for installation, reading and taking simple measurement
- ✓ Perform calculation on distance, area, volume and discharge (yield production)
- ✓ Correct and minimize measurement errors
- ✓ Conduct checks and setting of GPS.
- ✓ Take track line and track point using GPS.
- ✓ Perform and saving the reading and measurement data.
- ✓ Load data to the computer which has GIS software

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets"
3. Accomplish the "Self-checks"
4. If you earned a satisfactory evaluation proceed to "the next information sheet However,
5. If your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
6. Submit your accomplished Self-check. This will form part of your training portfolio(if Necessary)
7. Read and Practice "Operation Sheets".
8. If you think you are ready proceed to "Job Sheet".
9. Request you facilitator to observe your demonstration of the exercises and give you feedback.

Information sheet #1	Prepare materials, tools and equipment for measurement

1.1 selecting and checking suitable personal protective equipment for male and female

Personal protective equipments (PPE): are devices worn, put on, tied on, or inserted in such as hearing protectors inserted in the ears of workers for protection against industrial hazard health hazards and accidents.

Personal protective equipments are used:

- As supplementary means of protection, and
- As direct means of protection

These materials include:-

- ✓ Protective clothing,
- ✓ Eye and face protectors,
- ✓ Ear protectors,
- ✓ Head protectors(safety helmets),
- ✓ Respiratory protectors,
- ✓ Hands and arm protectors,
- ✓ Foot and leg protectors,
- ✓ Other personal protective equipments.

Consider these factors when selecting PPE:

- Type of hazardous materials, processes, and equipment involved
- Routes of potential exposure (ingestion, inhalation, injection, or dermal contact)
- Available engineering controls
- Correct size for maximum protection
- Minimal interference with movement

- **Types of PPE**

Different types of PPE are described below

Use safety glasses for minor splash hazards, goggles for moderate hazards, and goggles combined with a face shield for severe hazards.

Hand protection

Hand protection is indicated for the possibility of severe cuts, lacerations, or abrasions, punctures, temperature extremes, and chemical hazards. (Nit rile loves are usually good choice for general use.) Use heavy-duty gloves for non-incidental contact and gross contamination

Body protection

Protective clothing includes lab coats, smocks, scrub suits, gowns, rubber or coated aprons, coveralls, uniforms, and pierce-resistant jackets and vests.

Foot protection

Workers must wear closed-toe shoes at all times to protect feet from chemical spills and sharp objects. Steel-toed footwear and puncture-resistant soles. Slip-resistant shoes (usually rubber-soled with a grip pattern) for anyone who works in wet environments.

Head protection

Hard hats must be worn by electricians, construction workers, and any other workers when there is a danger of objects falling from above.

1.2 Identifying suitable materials, tools and equipment.

- **Equipment**

Equipment is tangible and durable assets that are used in the production of other goods and services.
Examples of equipment are things like machinery, tools, devices, etc. Due to their prolonged use, equipment will tend to lose their value over time as a result of wear and tear. In accounting book keeping activities, equipment will be depreciated so that this loss in value can be correctly documented in the accounting books of the firm.

- **Materials**

Materials are also an essential input to the production process, as materials form the base of the product (the basic matter from which the product is made). Materials used will depend on the end product that is being produced, and maybe durable or perishable in nature. Materials can be further divided into direct materials and indirect materials.
Direct materials are the materials that can be directly associated with the manufacturing of the product such as cocoa in chocolate production. Indirect materials are the materials that cannot be directly traced back to the product such as office stationary.

Equipment, on the other hand, are the tools, machinery, devices that help create the product.
In other words, materials are molded, fixed, glued, and fastened together by the use of equipment and machinery to create the final product.
Equipment are durable assets that have a long term use, whereas **materials** have a short term use, and may also be perishable in nature.
• Equipment and materials are similar as they are both essential inputs in the manufacturing process.
• Equipment is tangible and durable assets that are used in the production of other goods and services. Examples of equipment are things like machinery, tools, devices, etc.
• Materials are also an essential input to the production process as materials form the base of the product (the basic matter from which the product is made).
• Materials maybe durable or perishable in nature, and are molded, fixed, glued, and fastened together by the use of equipment and machinery to create the final product.

- **What is a Tool**

Any physical item that is used to achieve a goal but is not consumed during this process can be defined as a tool.

Tools can perform a variety of functions such as cutting and chopping, moving, shaping, fastening, guiding, enacting chemical changes, fastening, information and data manipulation, etc. There can be specific tools designated for specific purposes whereas most tools can serve a combination of uses.

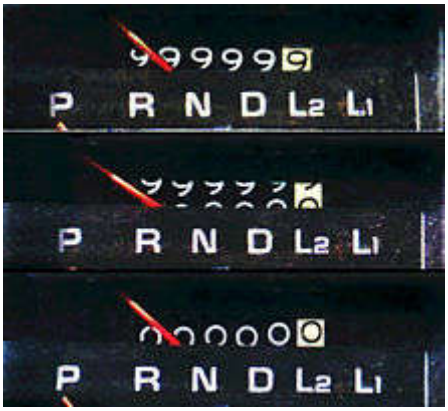
Selecting equipments and tools used for measurement

Equipments and tools may include;-

- Rulers :-measure the short distance
- Tape /chains:- are used for measuring the straight line b/n two points
- tape measures were mainly used for the measuring of the human's waist line.
- Trundle wheel
- Calculators:-
- Laser:-
- A measuring rod is a tool used to physically measure lengths and survey areas
- A hypsometer is an instrument for measuring height or altitude
- Gunter's chain also known as Gunter's measurement or surveyor's measurement) is a distance measuring device used for *land survey*.
- GPS:- measure the elevation and others
- Clinometers:-measure the diameter of the tree
- Odometer:-it measures the distance by counting the no of revolution made by the wheel.
- Pedometer:-which count the no of paces
- Pacing :- measure the average length of the pace
- Trip meters:- a trip meter is reset at any point in a journey, making it possible to record the distance traveled in any particular journey or part of a journey.

Plastic tape measure (metric)

GPS



Architect's scale

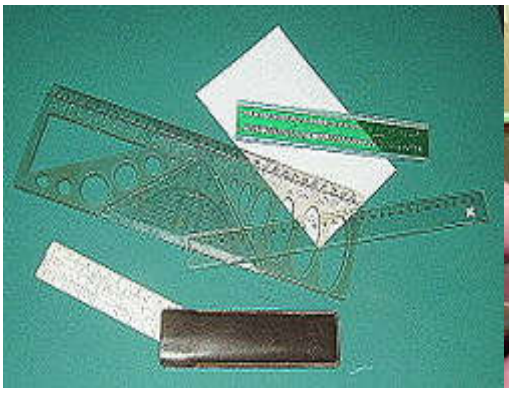
Odome-

ter

A triangular architect's scale, made of brass

Ruler

A flexible ruler stretched.



A variety of rulers

-meter carpenter's rule

- ✓ **A** ruler, sometimes called a rule or line gauge, is an instrument used in geometry, technical drawing, printing, engineering and building to measure distances or to rule straight lines. The ruler is a straightedge which may also contain calibrated lines to measure distances.

- ✓ An architect's scale is a specialized ruler designed to facilitate the drafting and measuring of architectural drawings, such as floor plans and orthographic projections. Because the scale of such drawings are often smaller than life-size, an architect's scale features multiple units of length and proportional length increments.
- ✓ A GPS receiver with odometer mode is also an excellent and inexpensive means to verify proper operation of both the speedometer and odometer mounted in a vehicle.
- ✓ A hypsometer is an instrument for measuring height or altitude. Two different principles may be used: trigonometry and atmospheric pressure.
- ✓ A measuring rod is a tool used to physically measure lengths and survey areas of various sizes.
- ✓ Gunter's chain or the surveyor's chain (also known as Gunter's measurement or surveyor's measurement) is a distance measuring device used for land survey.
- ✓ The measuring tapes: Tape measures that were intended for use in tailoring or dressmaking were made from flexible cloth or plastic.

1.3. Conducting checkup on all materials, tools and equipment.

Before you go to the field work you should have to check the sufficiency of the material (availability), faulty items reported and check on the quality of tools to operate on the field. Before and after using the different materials in the field it is very important to check the equipment. This makes the equipment free from some things unpleasant, undesirable, damaging that happen unexpected during work operation in the work place. If the materials are damaged it is possible to report to the supervisor immediately. Every nursery should have a sufficient supply of tools for different operations. A good care should be taken of the tools, which would then have a long life. It is not wise to keep workers sitting idle at critical periods of work because of shortage of tools. All tools should be hung or otherwise stored in fixed place in the nursery where they can be readily found. They should be stored in-groups of similar articles so that checking to ensure that all have been returned after work done at a glance.

1.4. Identifying and reporting occupational health and safety hazards

Identifying and reporting OHS hazards

Work is completed to supervisor's satisfaction and in accordance with Occupational Health and Safety requirements.

- ➢ **Why is occupational health and safety important?**

Work plays a central role in people's lives, since most workers spend at least **eight hours** a day in the workplace, whether it is on afield, in an office, factory, etc. Therefore, work environments should be safe and healthy. Yet this is not the case for many workers. Every day workers all over the world are faced with a multitude of health hazards, such as: gases; noise; vibration; Extreme temperatures

- ➢ **Identifying hazards and controlling risks**

Being able to identify hazards is crucial in ensuring tasks are carried out safely. Your past experience in the workplace may help you to identify some hazards, but remember to also use the skills and knowledge of those around you to help.
Identifying hazards and controlling risk must be done continuously as new work processes, tasks, equipment and workers come into the workplace. Part of this process may be to ask your employer to employ or engage a suitably qualified occupational health and safety professional to come into the workplace to provide advice on health and safety.

- **Some ways to identify hazards and control risks:**

1. Talk with workers (including contractors) who are or will be performing any tasks to identify all potential hazards and the best ways to eliminate or reduce risk.
2. Make sure you are aware of any high risk activities, work with new machinery or new work processes before they happen.
3. Understand the hazards associated with tasks you supervise and have risk controls in place before work starts. This could mean preventing work from being done while a safety issue is being resolved.
4. Take action to resolve health and safety issues as soon as possible. This includes escalating the issue to more senior management if necessary. Once agreement is reached on how to fix a problem, implement it as soon as possible.

- **Identifying workplace hazards**

Every workplace has hazards. As an employer, you have a legal responsibility to look after your employees' safety and protect them against health and safety hazards at work.
In order to manage workplace health and safety and help prevent accidents and sickness absence, it's important to identify, monitor and reduce the risk associated with workplace hazards.

- **What are workplace hazards?**

Simply put, workplace hazards are any aspect of work that cause health and safety risks and have the potential to harm.
Some hazards are more likely to be present in some workplaces than others, and depending on the work that you do; there will be hazards that are more or less relevant to your business.

- **What are the most common workplace hazards?**

There are many types of workplace hazards, which tend to come under four main categories:

- ✓ physical hazards – the most common workplace hazards, including vibration, noise and slips, trips and falls;
- ✓ ergonomic hazards – physical factors that harm the musculoskeletal system, such as repetitive movement, manual handling and poor body positioning;
- ✓ chemical hazards – any hazardous substance that can cause harm to your employees;
- ✓ biological hazards – bacteria and viruses that can cause health effects, such as hepatitis, HIV/AIDS and Legionnaire's disease.

- **Common health risks**

Some of the most common health risks associated with workplace hazards include:

- ✓ Breathing problems;
- ✓ Skin irritation;
- ✓ Damage to muscles, bones and joints;
- ✓ Hearing damage;
- ✓ Reduced wellbeing.

- **How to prevent workplace hazards**

The best way to protect yourself and your employees from workplace hazards is to identify and manage them and take reasonable steps to prevent their potential to harm.
In order to control workplace hazards and eliminate or reduce the risk, you should take the following steps:

- ✓ identify the hazard by carrying out a workplace risk assessment;
- ✓ determine how employees might be at risk;
- ✓ evaluate the risks;

- **Record and Identifying workplace hazards**

Every workplace has hazards. As an employer, you have a legal responsibility to look after your employees' safety and protect them against health and safety hazards at work.
In order to manage workplace health and safety and help prevent accidents and sickness absence, it's important to identify, monitor and reduce the risk associated with workplace hazards.

- **How to prevent workplace hazards**

The best way to protect yourself and your employees from workplace hazards is to identify and manage them and take reasonable steps to prevent their potential to harm.
In order to control workplace hazards and eliminate or reduce the risk, you should take the following steps:

- ✓ identify the hazard by carrying out a workplace risk assessment;
- ✓ determine how employees might be at risk;
- ✓ evaluate the risks;
- ✓ record and review hazards at least annually, or earlier if something changes.

- **To identify and assess hazards, employers and workers**:

- ✓ Collect and review information about the hazards present or likely to be present in the workplace.
- ✓ Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards.

- ✓ Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings.
- ✓ Group similar incidents and identify trends in injuries, illnesses, and hazards reported.
- ✓ Consider hazards associated with emergency or no routine situations.
- ✓ Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective actions.

- ➢ **"Hazard Prevention and Control."**

Action item 1: Collect existing information about workplace hazards
Action item 2: Inspect the workplace for safety hazards
Action item 3: Identify health hazards
Action item 4: Conduct incident investigations
Action item 5: Identify hazards associated with emergency and no routine situations
Action item 6: Characterize the nature of identified hazards, identify interim control measures, and prioritize the hazards for control.

Self-Check 1	**Written Test**

Name: _____ Date: _____

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

1. Explain the importance of selecting suitable PPE? (5pt)
2. What is PPE? (5pt)
3. List and explain the different types of PPE? (5pt)
4. Explain risk management process? (5pt
5. What is occupational health and safety? (5pt)
6. Define hazard? (5pt)
7. Explain and list the class of hazards? (5pt)
8. Explain OHS hazards associated with equipment operation? (5pt)

Note: **Satisfactory rating - 20 points and above Unsatisfactory - below 20 points**
You can ask your teacher for the copy of the correct answers.

Information sheet #2	Perform simple measurement techniques

2.1 Using techniques for installation, reading and taking simple measurement

Definition:

Measurement: - is the way that numbers are used most often in the trades.
Measurement and calculation: - are used to measure and describe the physical world, for example by taking measurements and calculating area and volume.
These are some of the things that we measure in everyday living.

Time	**Speed**	**Money**
Distance or length	**Temperature**	**Area**
Mass	**Volume**	**Capacity**

To measure quantities like mentioned above, units of measurement are required. The system of units used could be the **metric system.** Calculations in metric system are easy, because they are based on powers of 10 just like in our decimal system. The following units are most commonly used and it is important to remember their symbols (or shortened form).

	Name of unit	Symbol	Value
	millimeter centimeter **meter** kilometer	mm cm m km	10mm = 1cm 100cm = 1m 1000m = 1km
	milligram **gram** kilogram tonne	mg g kg t	1000mg = 1g 1000g = 1kg 1000kg = 1t
	second minute **hour** day	s min h day	60s = 1min 60min = 1h 24h = 1day
	degrees Celsius	°C	

	square millimeter square centimeter **square meter** hectare	mm^2 cm^2 m^2 ha	$1cm^2 = 100\ mm^2$ $1\ m^2 = 10{,}000\ cm^2$ $1\ ha = 10{,}000\ m^2$
	cubic millimeters cubic centimeters **cubic meters**	mm^3 cm^3 m^3	$1cm^3 = 1000\ mm^3$ $1\ m^3 = 1{,}000{,}000\ cm^3$
	milliliter **liter** kilolitre	mL L kL	1000ml = 1 L 1000L = 1kL
	meters per second **kilometers per hour**	ms^{-1} kmh^{-1}	

Engineering Notation	Prefix	Symbol
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	m
10^{-9}	nano	n
10^{-12}	pico	p

2.2. Performing calculation on distance, area, volume and discharge (yield production)

A. Distance

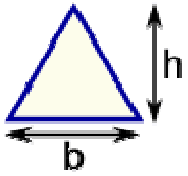
Often assigned the **variable *d*,** is a measure of the space contained by a straight line between two points. **Distance** can refer to the space between two stationary points (for instance, a person's height is the distance from the bottom of his or her feet to the top of his or her head) or can refer to the space between the current position of a moving object and its starting location. Most distance problems can be solved with the following equations.

$\mathbf{d = s_{avg} \times t}$,where **d** is distance, $\mathbf{s_{avg}}$ is average speed, and **t** is time, or using

$\mathbf{d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}$, where (x_1, y_1) and (x_2, y_2) are the x and y coordinates of two points.

B. Area of Plane Shapes

Area is the size of a surface!

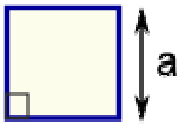


Triangle

Area = ½ × b × h

b = base

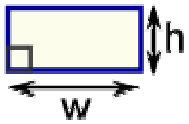
h = vertical height



Square

Area = a^2

a = length of side

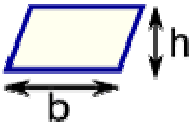


Rectangle

Area = w × h

w = width

h = height

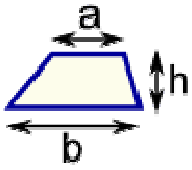


Parallelogram

Area = b × h

b = base

h = vertical height



Trapezoid (US)

Trapezium (UK)

Area = ½(a+b) × h

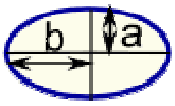
h = vertical height

Circle

Area = $\pi \times r^2$

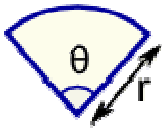
Circumference = $2 \times \pi \times r$

r = radius



Ellipse

Area = πab

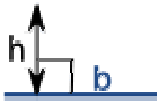


Sector

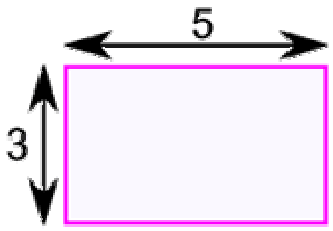
Area = $\frac{1}{2} \times r^2 \times \theta$

r = radius

θ = angle in **radians**

Note:**h** is at right angles to b: 

Example 1: What is the area of this rectangle?



The formula is:

Area = w × h

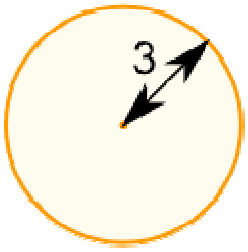
w = width

h = height

We know **w = 5** and **h = 3**, so:

Area = 5 × 3 = **15**

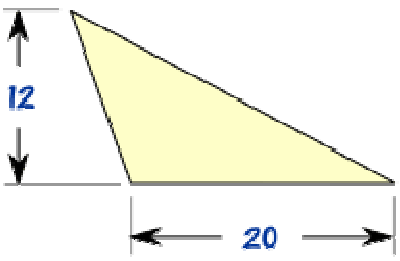
Example 2: What is the area of this circle?



Radius = r = 3

$$\begin{aligned} \text{Area} &= \pi \times r^2 \\ &= \pi \times 3^2 \\ &= \pi \times (3 \times 3) \\ &= 3.14159... \times 9 \\ &= \mathbf{28.27} \text{ (to 2 decimal places)} \end{aligned}$$

Example 3: What is the area of this triangle?



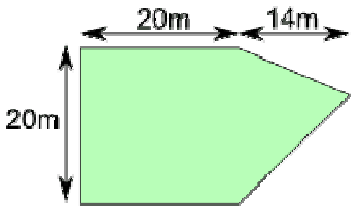
Height = h = 12

Base = b = 20

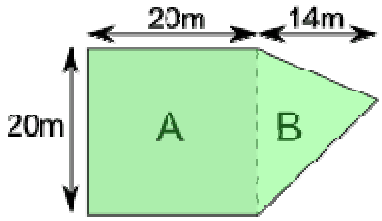
Area = ½ × b × h = ½ × 20 × 12 = **120**

Example 4: Sam cuts grass at $0.10 per square meter

How much does Sam earn cutting this area?



Let's break the area into two parts:



Part A is a square:

Area of A = a^2 = 20m × 20m = 400m^2

Part B is a triangle. Viewed sideways it has a base of 20m and a height of 14m.

Area of B = ½b × h = ½ × 20m × 14m = 140m^2

So the total area is:

- **Area = Area of A + Area of B = 400m^2 + 140m^2 = 540m^2**

Sam earns $0.10 per square meter

Sam earns = $0.10 × 540$m^2$ = $54

C. Volume

The amount of space occupied by an object is called its volume. Cubic units are used to measure the volume. (eg. cm^3, m^3, liter ha-m etc).

The volume of a rectangular prism = length × width × height

Prism is a three dimensional object which has a uniform cross sectional area. In this prism, the cross section is a rectangle. This is called a rectangular prism.

$$V = l \times w \times h$$

The volume of a prism = Area of the base × height

$V = A \times h$

Where A is the area of the base and *h* is the height of the prism.

Example 1: Let's find the volume of prism whose length = 4cm, *width* = 3cm, *and height* = 5cm

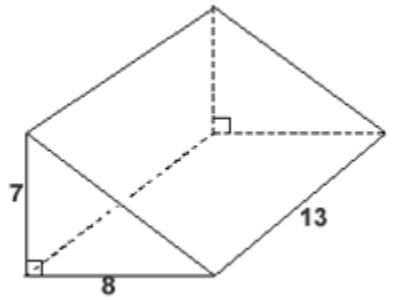
To find the volume of the prism, we can use the above formula.

$V = l \times w \times h$

$V = 4 \times 3 \times 5\ cm^3$

$= \quad 60\ cm^3$

Example 2: Let's find the volume of the following figure.



To find the volume of the prism, we can use the formula V = A × h where A is the area of the base (or area of the cross section) and h is the height (or the length of the prism)

The base of the prism is a triangle, so we need to find the area of the triangle.

Area of a triangle (A) = ½ b × h = ½ × 8 × 7 = 28 cm^2

The height of the prism (h) (or the length of the prism) = 13 cm

Volume of the prism = A × h = 28 × 13 = 364 cm

Example 3:

Area of the cross section(A) $= \pi \times r^2$, where r is the radius.

The diameter of the circular cross section = 12.8cm

∴ the radius of the circular cross section = 12.8 ÷ 2 = 6.4cm

Area of the cross section(A) $= \pi \times r^2 = 3.142 \times 6.4 \times 6.4 = 128.7cm^2$

The height of the cylinder(h) = 10cm

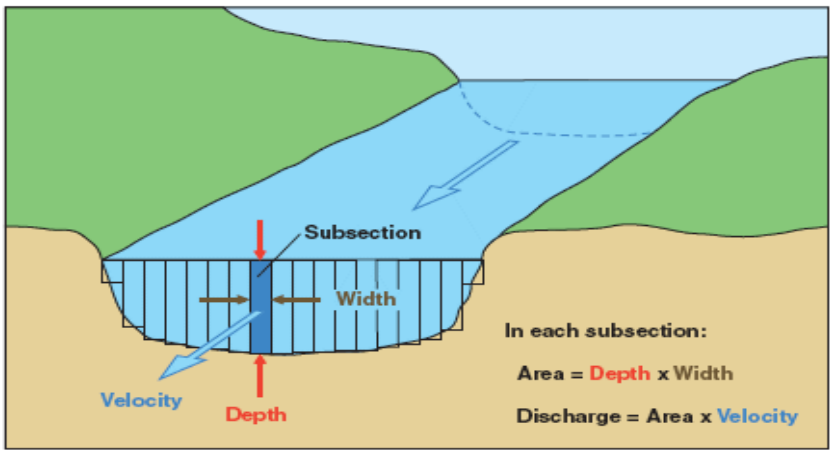
The volume of the cylinder = A × h = 128.7 × 10 $= 1287cm^3$

D. Discharge measurements

Discharge is the volume of water moving down a stream or river per unit of time, commonly expressed in cubic feet per second or gallons per day. In general, river discharge is computed by multiplying the area of water in a channel cross section by the average velocity of the water in that cross section:

Discharge = area x velocity.

There are numerous methods and types of equipment to measure velocity and cross-sectional area, including the following current meter and Acoustic Doppler current Profiler.



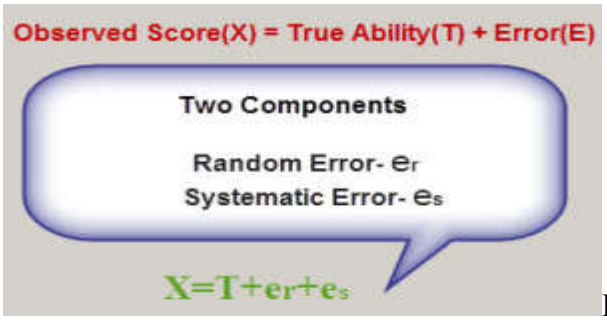
Current-meter discharge measurements are made by determining the discharge in each subsection of a channel cross section and summing the subsection discharges to obtain a total discharge.

Current Meter

The most common method used for measuring discharge is the mechanical current-meter method. In this method, the stream channel cross section is divided into numerous vertical subsections (see figure above).In each subsection, the area is obtained by measuring the width and depth of the subsection, and the water velocity is determined using a current meter. The discharge in each subsection is computed by multiplying the subsection area by the measured velocity. The total discharge is then computed by summing the discharge of each subsection.

2.3. Correcting and minimizing measurement errors.

Different types of errors in measurement and measurement error calculation



Error Formula: X= T +e_r + e_s

The measurement of an amount is based on some international standards which are completely accurate compared with others. Generally, measurement of any quantity is done by comparing it with derived standards with which they are not completely accurate. Thus, the errors in measurement are not only due to error

in methods, but are also due to derivation being not done perfectly well. So, 100% measurement error is not possible with any methods.

It is very important for the operator to take proper care of the experiment while performing on industrial instruments so that the error in measurement can be reduced. Some of the errors are constant in nature due to the unknown reasons, some will be random in nature, and the other will be due to gross blunder on the part of the experimenter.

- **Errors in Measurement System**

An error may be defined as the difference between the measured value and the actual value. For example, if the two operators use the same device or instrument for finding the errors in measurement, it is not necessary that they may get the similar results. There may be a difference between both measurements. The difference that occurs between both the measurements is referred to as an **error**. Sequentially, to understand the concept of errors in measurement, you should know the two terms that define the error. They are *true value* and *measured value*.

The *true value* is impossible to find out the truth of quantity by experimental means. It may be defined as the average value of an infinite number of measured values.

Measured value can be defined as the estimated value of true value that can be found by taking several measured values during an experiment.

- **Types of Errors in Measurement System**

Generally errors are classified into three types: systematic errors, random errors and blunders.

1) Gross Errors
2) Blunders
3) Measurement Errors

1) Gross Errors

Gross errors are caused by mistake in *using instruments or meters, calculating measurement and recording data results*. The best example of these errors is a person or operator reading pressure gage $1.01N/m^2$ as $1.10N/m^2$.

It may be due to the person's bad habit of not properly remembering data at the time of taking down *reading, writing and calculating*, and then presenting the wrong data at a later time. This may be the reason for gross errors in the reported data, and such errors may end up in calculation of the final results, thus deviating results.

2) Blunders

Blunders are final source of errors and these errors are caused by faulty recording or due to a wrong value while recording a measurement, or misreading a scale or forgetting a digit while reading a scale. These blunders should stick out like sore thumbs if one person checks the work of another person. It should not be comprised in the analysis of data.

3) Measurement Error

The measurement error is the result of the variation of a measurement of the true value. Usually, measurement error consists of **a random error and systematic error**. The best example of the measurement error

is, if electronic scales are loaded with 1kg standard weight and the reading is 10002grams, then the measurement error is = (1002grams-1000grams) =2grams.

Measurement Errors are classified into two types:

- systematic error and
- random errors

a. Systematic Errors

The Systematic errors that occur due to fault in the measuring device are known as systematic errors. Usually they are called as Zero Error – a positive or negative error. These errors can be detached by correcting the measurement device. These errors may be classified into different categories.

Categories of systematic Errors

- Instrumental Errors
- Environmental Errors
- Observational Errors
- Theoretical

Instrumental Errors

Instrumental errors occur due to wrong construction of the measuring instruments. These errors may occur due to hysteresis or friction. These types of errors include loading effect and misuse of the instruments. In order to reduce the gross errors in measurement, different correction factors must be applied and in the extreme condition instrument must be recalibrated carefully.

Environmental Errors

The environmental errors occur due to some external conditions of the instrument. External conditions mainly include pressure, temperature, humidity or due to magnetic fields.

Observational Errors

As the name suggests, these types of errors occurs due to wrong observations or reading in the instruments particularly in case of energy meter reading. The wrong observations may be due to parallax.

Theoretical errors

Theoretical errors are caused by simplification of the model system. For example, a theory states that the temperature of the system surrounding will not change the readings taken when it actually does, then this factor will begin a source of error in measurement.

b. Random Errors

Random errors are caused by the sudden change in experimental conditions and noise and tiredness in the working persons. These errors are either positive or negative. An example of the random errors is during changes in humidity, unexpected change in temperature and fluctuation in voltage.

Measurement Error Calculation

There are several ways to make a reasonable measurement error calculation such as estimating random errors and estimating systematic errors.

Estimating Random Errors

There are a number of ways to make a reasonable estimate of the random error in a particular measurement. The best way is to make a series of measurements of a given quantity (say, x) and calculate the mean and standard deviation ($\bar{x}$ & σ_x) from this data. The mean $\bar{x}$ is defined as follows:

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Where, X_i is the result of the i^{th} measurements, 'N' is the number of measurements

The standard variation is given by:

$$\sigma_x = \left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{1/2}$$

If a measurement is repeated many times, then 68% of the measured valves will drop in the range $\bar{x} \pm \sigma_x$

We become more positive that, is an accurate representation of the true value of the quantity $\bar{x}$.

The standard deviation of the mean σ_x is defined as:

$\sigma(\bar{x}) = \sigma_x / \sqrt{N}$

The quantity σ_x is a good estimate of our uncertainty in $\bar{x}$. Notice that the measurement precision increases in proportion to $\sqrt{N}$ as we increase the number of measurements.

The following example will clarify these ideas. Assume you made the following five measurements of a length:

Corrections for Baseline Measurement

1. Baseline Correction for Absolute Length:

It is given by the formula

$$CA = \frac{L.C}{l}$$

Where CA = Correction for absolute length

L = measured length of base

l = Nominal length of measuring unit

C = Correction to measuring unit

Sign of CA is the same as that of C

Nominal length: The designated length i.e. 50m tape, 100m tape (30 m tape)

Absolute length: The actual length under specified conditions

2. Correction for Temperature: It is given by the formula

$$Ct = \propto L(Tm - To)$$

Where ,Ct = Correction for temp

$\propto$ = co-efficient of thermal

Tm = Mean Temperature during measurement

To = Temp at which the measuring is standardized

$\propto$Steel = 0.0000099 - 0.000012/^{0}c

$\propto$Steel = 0.0000055 – 0.0000070/ ^{0}F

The sign of 'Ct' is plus or minus according to as 'Tm' is greater or less than 'To'

3. **Correction for Pull or Tension is given by:**

$$Cp = \frac{(Pm - Po)}{AE} L$$

,Where CP = Correction for pull

Pm = Pull applied during measurement

Po = Pull at which the measurement unit (tape) is standardized

L = length measured

A = Cross-Sectional area of measuring unit

E = Modulus of elasticity of measuring unit

E steel = 21 x 105 kg /cm^2

E steel = 30 x 106 lb/in^2

The sing of this correction is always plus (T) as the effect of pull is to increase the length tape and consequently to decrease the measured length of the base.

4. Correction for Sag:

Correction for sag is the deference in length b/n the curved length of the laps and the distance between the supports. It's us required only when the tape is suspended during measurement.

Since the effect of sag is to make the measured length too large, it is always subtractive. It is given by the following formula.

$$Cs = \frac{L_1 (WL_1)^2}{24Pm^2}$$

Where Cs = Correction for Sag

L_1 = Distance b/t supports.

W = wt of tape per unit length

Pm = applied pull

$$CS = \frac{L(WL)^2}{24Pm^2} = \frac{W^2L^3}{24Pm^2} = \frac{W^2L'}{24Pm^2}$$

W = weight of tape between supports.

If there are 'n' equal space per tape length, $L = nL_1$

Sag correction per tape length is given by:

$$Cs = \frac{nL_1(WL_1)^2}{24Pm^2} = \frac{L(WL_1)^2}{24Pm^2} = \frac{L(WL)^2}{24nPm^2}$$

Total sag correction to measured length

Cs=N x Cs/ + Cs// , Where N = no of whole tape length

Cs/ = Sag correction per tape length.

Cs// = Sag correction for any tape length

Normal tension:

The normal tension of a tape is a tension which will cause the effects of pull and sag to neutralize each other. It may be obtained by equating the corrections for pull and sag.

$$Pn = \frac{0.204W\sqrt{AE}}{\sqrt{Pn - Po}}$$

Where Pn = normal tension

W = wt of tape b/n supports

Pn is determine by trial

5. Correction for Slope or Vertical Alignment:

This correction is required when the points of supports are not exactly at the same level

L_1, L_2---------- = Successive length of uniform garages

B_1, B_2---------- = Difference of elevation between the extremities of each of these grades.

Cg = corr for slope

$Cg = B_1C_1 = AC1 - AB_1 = l - D$

$$Cg = l - \sqrt{l^2 - h^2} \rightarrow \text{Exact}$$

This correction is always negative for measured length.

In order to reduce the environmental errors

- Try to maintain the humidity and temperature constant in the laboratory by making some arrangements.
- Ensure that there shall not be any external electrostatic or magnetic field around the instrument.
- In order to reduce the parallax error highly accurate meters are needed: meters provided with mirror scales.

Self-Check – 2	**Written Test**

Name: _____ **Date:** _____

Directions: **Answer all the questions listed below.**

1. Explain the meaning distance, and discharge, volume, area? (5pts)

2. Write the unit and symbols of unit measurement (quantities)? (5pts)
3. Explain engineering notation and write there symbol and prefix (5pts)
4. List base line correction methods (5)
4. Let's calculate the volume of prism its L=2.2m, w=1.5m, H=1m? (5pts)
5. Let's calculate the discharge of river with its area 4m2 and velocity 2m/sec (A)(5pts)

Note: **Satisfactory rating – 15 points and above Unsatisfactory - below 15 points**

You can ask your teacher for the copy of the correct answer

Information sheet #3	**Working with hand held global positioning**

3.1. Conducting checks and setting of GPS.

What is GPS? GPS, the Global Positioning System, is a satellite-based system that allows anyone with a GPS receiver to find their exact position anywhere in the world. It is used as an aid in navigation, for example in airplanes, in boats and by hikers. The GPS receiver uses the signals from the satellites to calculate its latitude, longitude and (sometimes) elevation. Most receivers also have the capability to store locations (known as **waypoints**), Sequences of locations that make up a planned **route** and a track log or **track** of the receivers movement over time.

Waypoints, routes and tracks are the three basic feature types in GPS data.

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS works in any weather conditions, anywhere in the world, 24 hours a day, with no subscription fees or setup charges. The U.S. Department of Defense (USDOD) originally put the satellites into orbit for military use, but they were made available for civilian use in the 1980s.

How to use GPS

GPS tools are now used in cars, boats, planes, construction equipment, and movie making gear, farm machinery, and laptop computers. Our interest in them lies mostly with use in hiking and backpacking experiences, but we have great units for auto travel as well. And, we have devices that combine use of GPS satellites with communication satellites that allow backcountry travelers to stay in touch with home, and for those at home to know where the user is located.

Handheld units

There are many different styles, types and sizes of GPS units available, and all will, and won't, do certain thing of importance to hikers. Watch our video on our GPS units. For example, here are a few practical things you can do with a good GPS unit while exploring the woods:

- ✓ Pinpoint your exact location in longitude and latitude even when it’s dark, foggy, or you don't otherwise have the slightest idea where you are.
- ✓ Determine the distance and direction from your location to another specified point.

- ✓ Mark where you park your car, so you always know which way to get back.
- ✓ Establish your altitude, and track your elevation history as a profile.
- ✓ Automatically trace a route you are hiking, so you can retrace your steps if necessary without getting lost.
- ✓ Show what direction you need to go to get back on track.
- ✓ Mark locations along your route, or intended route, with "waypoints" - like digital bread crumbs and flag markers,
- ✓ If you will. Offer traditional navigation assistance with a built-in digital compass, if available.

The basic GPS skills are:

1. How to set a waypoint of your current location;
2. How to enter the coordinates of a different location from a map or other reference source;
3. How to determine directions from your current location to another waypoint;
4. How to use the built in compass and altimeter;
5. How to replace the batteries.

It is easy to learn in a few minutes of experimenting or reading the instructions.

3.2. Taking track line and track point using GPS

Types of Points

There are waypoints, track points, via points, points of interest, events, icons, cities, exits, etc. They all have at least a two dimensional coordinate - latitude/longitude, easting/northing, etc. - because they are all geographic locations. Some will have the elevation too. They are defined by the role they play and the attributes they have.

Waypoints

Besides the coordinates (2D or 3D) waypoints have a name and usually a symbol (airport, square, dot, stadium, bridge, point slag, building, bus stop, etc.). Waypoints may also have a color for the symbol and/or name text, how to display, depth, proximity distance (for proximity alarms), and a text field (comment, message, description).

Waypoints stand by themselves - are independent of other points. Waypoints are shown as a "point" on either the receiver's screen or the computer screen. The "point" can be some sort of symbol (icon) to represent the type of location.

Waypoint is simply a unique address for any point in the world, but instead of the traditional Street/city/state/zip format we're used to for road travel, GPS units utilize waypoints expressed in mapping formats such as latitude/longitude or the UTM Grid. A waypoint is saved to your GPS by either "marking" a location with the appropriate button on the GPS.

Tracks and Track points

The receiver usually records track points as you travel. The track points define a track formed by connecting the points with lines. The "track" would represent the road, trail, path, etc. that you followed. Curves are formed with short line segments. The GPS receiver draws your track on the map screen with lines defined by the track points and a mapping program (with GPS support) draws your track on the computer screen (with or without background maps). The purpose of track points is to define lines for forming two dimensional ("linear") features. In general track points don't have names or symbols. They may have a date/time stamp that allows the speed to be calculated for the track segment (track leg - line connecting two track points). The distance is calculated from the location coordinates. The elevation is often recorded too so it's possible to get an elevation profile for the track or a 3D view of it along with average speeds, time, and total distance, etc. depending on the computer program or capabilities of the receiver (don't expect much from the receiver).With some computer programs you can draw a "track" and transfer it to the GPS receiver for a road or trail map or coast outline, etc. The Lawrence Finder does not store a date/time stamp or elevation on track points.

A track has a datum for all its points, a color and a width (in pixels) used in displaying it on the map. The color will be sent to the GPS receivers supporting it, in which process a color matching algorithm will be applied if the original color is not in the set of colors accepted by the receiver. Any color matching algorithm may give unexpected results and the one used in GPS Man is no exception.

To navigate to a specific waypoint, first find the full list of waypoints on your GPS.
This may be a simple as pressing the "find" button on your GPS if it has one, or otherwise shuffling through the menu pages until you find an option on a page named **"waypoints".** Once you've selected the "waypoints" option, you should see a list of waypoints
Most GPS units will allow you to sort the waypoint list in **alphabetical sequence**, or to list the waypoints that are closest to you first.
Once you have found the waypoint of interest, scroll down to it and press the GPS **ENTER** key. That will take you to a new page with more detailed information about that waypoint, which may include its coordinates, distance and direction from your current location, and elevation, etc.

You can usually also **edit** the name or **delete** it from this menu page. The option we're interested in is "**GO-TO"** or similar menu choice – highlights that and press **ENTER**.
The GPS is only showing you ,**distance in a straight line**, without regard to the actual curvature or meandering of trails to get to that point, nor is it telling you of barriers between you and the waypoint – canyons, rivers, mountains, etc. For that, you have to use a top map to more accurately determine a route to your destination.
How to mark a waypoint:
A waypoint is simply a unique address for any point in the world, but instead of the traditional street/city/state/zip format we're used to for road travel, GPS units utilize waypoints expressed in mapping formats such as latitude/longitude or the UTM Grid. The GPS determines your location by receiving signals from orbiting satellites which determine distances from each satellite, triangulating a location on earth that is expressed in a mapping format. For example, the Lower Gear Backpacking Center is located at 1828 E. Uni-

versity Drive, Tempe, AZ 85281. But to a GPS, our location would be more commonly expressed in one of these formats, which all point to the same location:
12S 415638E 3698162N33°
25’ 16” N 111° 54’ 27” W
33° 25.274N 111° 54.443’ W

3.3. Performing and saving the reading and measurement data.

How to use GPS-enter coordinate

This article discusses how to manually enter a waypoint coordinate on a GPS device and why and when you might want to do so. We often use a basic Garmin unit as our go-to example, but all GPS units function in very similar ways and have similar features.

Before you start with these instructions, learn which keys, buttons or menu selections activate the following basic functions on the GPS you’re using*:*

- ✓ Move between **pages or menu screen** – Usually a button labeled “Page”. Like choosing between open programs or tabs on your computer screen.
- ✓ Scroll within choices on a page – this may be a “rocker” button or two “up-and-down” buttons, similar to the function a mouse or cursor movers does on a computer.
- ✓ Select a choice – usually a button that says “Enter”. Serves the same function as the enter key on a computer or “OK” on a Smartphone.

How to set your GPS for auto-tracking:

Most GPS units have a feature that records a “track” - a series of waypoints every few seconds or at some set interval – that can be saved for subsequent use, such as returning to your original spot via the exact same route by following the GPS, or following a faint trail again at a later date as examples. Tracks can also be uploaded to a GPS and used in mapping or routing software of various types.

Most GPS units have a menu option called “tracks” on their main or home menu page. Select this option and you’ll typically see sub-options such as:

- ✓ Turning the feature ON OR OFF -turn off to save battery life when not using the feature>
- ✓ **Track interval** – can be left at its default interval, or set to record at intervals of time or distance>
- ✓ What to do when at full capacity – there is some limitation on the number of tracks a device can hold, so you can tell the GPS to either quit when at capacity, or to wrap around and replace the beginning with new tracks so you always have the latest tracks saved. >
- ✓ **Edit/Save/Delete** – you may want to clear out old tracks to make room for new recordings after you’ve saved a track, you can re-trace your steps and navigate the track route by using the GPS navigation features. Most GPS units will allow you to choose to either follow the track from beginning to end, or from end to beginning. For information on how to navigate with the GPS, see our article

How to Navigate a Waypoint with a GPS.

Following a track works the same way as being guided to a specific waypoint. Your GPS will show the track against a map background – usually represented by a dotted line – and you can look at the map to make sure you are still on course.

We have a nice library of how-to articles on this site. If you rent a GPS from Lower Gear, we will also include a print or online user guide with full details on how to use it. We are also available to assist you over the phone.

How to mark a waypoint with a GPS for more information:

The map will have reference coordinates marked at periodic intervals – every minute for example, or every kilometer on the UTM grid. Armed with one half of the coordinate pair from the GPS, find the closest reference points on the map, and estimate the distance you are between the tic marks. For example, assume the longitude tic marks are shown for 111 degrees, 25 minutes and 111 degrees, 26 minutes, etc. If the GPS shows you at 111 degrees, 25.345 minutes longitude then you knows you are approximately 1/3 of the way between the 2 map tic marks. Draw a vertical line down from that estimated point. Then do the same process for the latitude coordinates: assume the latitude tic marks are shown for 33 degrees, 43 minutes and 33 degrees, 44 minutes, etc. If the GPS shows you at 33 degrees, 43.769 minutes latitude then you knows you are approximately 3/4 of the way between the 2 map tic marks. Draw a horizontal line across from that estimated point.

3.4. Loading data to the computer which has GIS software

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships. With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands. Such a map would help people determine which wetlands are most at risk.GIS can use any information that includes location. The location can be expressed in many different ways, such as latitude and longitude, address, or ZIP code. Many different types of information can be compared and contrasted using GIS. The system can include data about people, such as population, income, or education level. It can include information about the land, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools, or storm drains, roads, and electric power lines.

How do I download waypoints and other data from my Garmin GPS to my computer?

These steps were written using a Garmin GPS 72H receiver. If you are using a different Garmin receiver, certain details may be different.

Step 1: Connect the GPS unit to the computer:

You will need a cable. Garmin makes one, of course, and there are also third-party cables available.

Step 2: Configure the GPS receiver:

Ensure that your GPS unit is "Garmin" transmission mode. For the Garmin 12 receiver, this is done by accessing the **Main Menu** page, choosing **Setup Menu**, then choosing **Interface**, highlighting the first line, then changing it to the **GRMN/GRMN** setting. For more information, consult your manual. If you do not have a manual, Garmin has manuals on-line (Go through the Products section and find your receiver, then go to the page about your receiver and there should be a link to a downloadable manual.)

Step 3: Start the download software:

There are many software solutions available for downloading waypoints from your GPS. I will introduce two options but there are others:

Garmin's software is called Map Source and is available from Garmin as part of any of their Map Source CDs.

There is free software called waypoint+ available that will allow you to download waypoints and other data from your GPS unit.

Whichever program you are using, start it.

Step 4: Download the waypoints:

Using the map source software, go to edit - preferences. in the preferences window, set distance and speed to metric and position format to 'lat/lon hddd.ddddd'. Click 'ok' to close the window and go to file - open from device. Select waypoints, routes and tracks to be downloaded and click on open.

Transferring tracks, routes, or waypoints tracks, routes and waypoints can be transferred between your device and a computer using map source.

Step 5: To transfer tracks, routes, or waypoints to and from map source:

Connect your device to the computer with a USB cable.

2. Open map source on your computer.
3. Select tracks, routes, or waypoints to transfer.
4. Click receives from device or sends to device on the map source transfer menu.

Connecting your device to a computer

1. Plug the small end of the USB cable into the mini- USB port on the back of the device (under the weather cap).
2. Connect the larger end of the USB cable to an available USB port on your computer.

Note: to check your connection, press menu twice > select setup > interface > connected Setup

The setup menu is arranged in a tab format. Each tab contains these things that determine how the GPS 72h functions. Use the rocker and the enter button to change settings.

General tab

The general tab contains settings for receiver mode, was, backlight time out, beeper, and language.

General tab page

Mode—allows you to choose from the following operation modes:

Normal—default mode set from the factory.

Use this setting for best performance.

Settings:- The main menu contains settings and features not found on the main pages and sub-menus. The main menu is accessible from any page by pressing menu twice. To select a menu item or customize an option, use the rocker and the enter button. Menu options used memory backlight battery indicator power Main menu page zoom in go to/ mob power quit rocker buttons Quit—press to return to the previous page and cycle through the main pages in reverse order.

Power—press and hold to turn the device on or off.

Press and release to adjust the backlight.

Go to/mob—press to begin or stop navigation to a waypoint.

Press and hold (man overboard function) to store the current location and begin navigation to that point.

Zoom in—press to zoom the map in.
Zoom out--- page menu enter/mark.

Self-Check 3	**Written Test**

Name: _____ **Date:** _____

Directions: ***Answer all the questions listed below*.**

1. What is GPS and Why we need GPS?(5pts)
2. What are track line and way point? Explain. (5 pts)
3. List the advantages of GPS? (5pts)
4. What is the purpose of GPS and GIS system? (5pts)
5. Write the advantage of GIS system? (5pts)
6. What is the advantage loading data from GPS to computer/GIS software? (5pt

Note: **Satisfactory rating – 15 points** **Unsatisfactory – below 15 points**

LAP Test	**Practical Demonstration**

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

You are required to perform any of the following

1. Identify different parts of GPS equipments according to their use and taking track line by GPS.
2. Report work out come to the teacher
3. Request your teacher for evaluation