Plumbing installation

Level-II

Learning Guide-30

Unit of Competence: Read plans and calculate plumbing quantities

Module Title: Reading plans and calculating plumbing quantities

LG Code: EISPLI2 M07 LO6-LG-30

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LO6: Obtain measurements and perform calculations

Instruction Sheet	Obtain measurements and perform calculations LG - 30

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

- Obtaining plumbing work measurements
- Applying quality requirement of calculations
- Obtaining plans measurements and dimensions
- Carrying out simple calculations

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:

- Obtain plumbing work measurements
- Apply quality requirement of calculations
- Obtain plans measurements and dimensions
- Carry out simple calculations

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet.
6. Do the “LAP test” (if you are ready).

Information Sheet-1	Obtaining plumbing work measurements

1.1 Measurement

It is the transformation of drawn information into descriptions and quantities, undertaken to value, cost, and price construction work, as well as enabling effective management. To measure is the act or process of determining the extent, quantity, degree, capacity, dimension, volume, and so forth, of a substance by comparing it with some fixed standard, which is usually fixed by law. There are many kinds of measures, and practically all of them are standard, but standards vary in different countries.

1.2 Purpose of obtaining measurements

It is necessary to use the correct device or instrument to obtain the measurements for the particular work task. It is also important to use the correct methods for measuring at a worksite. Each workplace will have specific work requirements but, in most cases the methods and tools for measuring are constant. It is important to make sure all measurements are accurate to ensure correct material requirements and to reduce wastage. Measurements that are incorrect can be costly to fix, or the standard of work may not be satisfactory.

Whenever measurements are taken, always check and then record them. Don't rely on memory as it only takes an interruption or moving away from the task to forget the measurement and possibly make an error. Some workplaces may have specific procedures for documenting measurements and numbers so it is important to know and understand the correct procedures for each site or organization.

1.3 Methods of obtaining the measurement

Obtaining measurements is a common task performed on every construction site and an essential skill for all types of construction work. For each type of work or task, there is usually a specific type of measurement related to it. These may include quantities, dimensions, volumes or distances.

The type of task or work application often determines the method for measurements you need to use. This may also be determined by the type and nature of materials being used in the construction process. In some workplace situations all measurements must be in line with specifications or standards relating to the job.

There are many examples of where measurement techniques and methods may be required. Some examples are included in the following table. meters (m^2)

It is necessary to know the units of measure for the worksite. The general practice in construction is to use the metric system and give measurements for length, width, height or depth in millimeters (mm) and meters (m). For example, 2400 mm lengths of timber, 100 mm PVC pipe, or a hole dug to 750 mm deep.

All weights are given as kilograms (kg) or tones (t). For example, a 20 kg bag of cement or a 5 kg bag of lime. Liters (l) and milliliters (mL) are the measurements used for liquids such as water, paint, solvents and liquid chemicals.

1.3 Instruction of plumbing work measurement

- Pipes shall be measured by length taken along the centerline and over all fittings.
- Valves shall be enumerated.
- Fixtures shall be enumerated and shall be understood as including all accessories valves, connection, control devices and supports for the satisfactory operation of the fixture.
- Duct Work shall be measured by length stating the girth.
- Connections to supply main shall be enumerated.
- Insulation to supply lines shall be measured by length specifying pipe diameter and along the centerline of the pipe.
- Catch pits and manholes shall be enumerated stating the size and shall be understood as including all earth, concrete and surface finish works. Connection of pipes to manholes and catch pits shall be understood as included.

Self-Check - 1	Written Test

Directions: Match the material, fixtures and installation line with its measurement unit.

1. Pipes
2. Valves
3. Fixtures
4. Supply line

A. Length

B. Enumerated.

Note: **Satisfactory rating - 2 and 4 points** **Unsatisfactory - below 2 and 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Name: _________________________ **Date:** _______________

Answer sheet

1. _____ **2.** _____ **3.** _____ **4.** ______

Information Sheet- 2	Applying quality requirement of calculations

2.1 Quality requirement

The quality of the work depends on the materials used and workmanship in the construction. All materials and workmanship shall be as per the specifications described in the contract/work order and shall be subjected from time to time to such tests as the Engineer directs at the place of manufacture, or on the work site or at such other places as may be specified.

The contractor shall provide such assistance, instruments, machines, labour and materials as are normally required for testing any work and shall supply samples of materials before use in the works for testing as required by the Engineer.

2.2 Quality measurement

Recording of measurements by the technical staff & check measurements by the officers are important aspects of execution of any civil engineering work.

Proper recording of measurements, check-measurements and maintenance of measurement books will avoid tampering of measurements. The following instructions should be strictly followed to avoid possible tampering of measurements.

- The entries in the measurement books are made in ink and no line shall be left blank. Any blank page left between shall be crossed and attested by the concerned officers.
- The "Contents or area" column shall be filled before check-measurement
- The recording shall be consistent and generally in the sequence of length, width & height or depth or thickness.
- The location of work should be clearly described so as to facilitate their easy identification and checking.

Self-Check - 2	Written Test

Directions: Write True or False for the question given below.

1. The quality of the work depends on the materials used and workmanship in the construction.
2. Testing of work and samples of materials are quality requirement.
3. Proper recording of measurements, check-measurements and maintenance of measurement books will tampering of measurements.
4. The recording shall be consistent and generally in the sequence of length, height & width or depth or thickness.

Note: **Satisfactory rating - 2 and 4 points** **Unsatisfactory - below 2 and 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Name: ___________________________ **Date:** ________________

Answer sheet

1. __________ **2.** __________ **3.** __________ **4.** __________

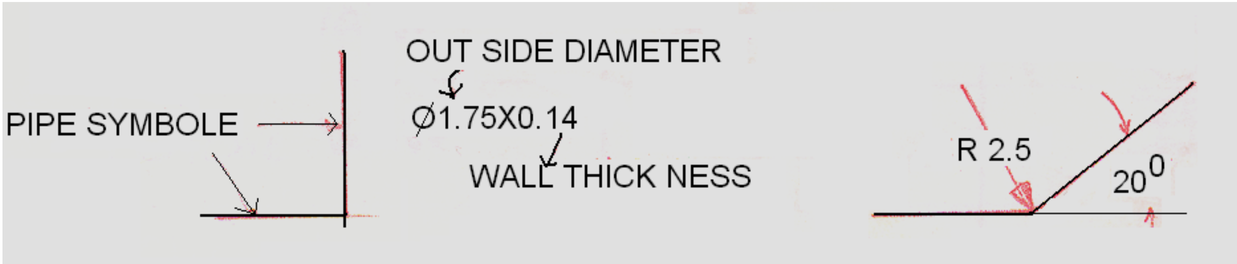
Information Sheet- 3	Obtaining plans measurements and dimensions

3.1 Identify plans measurement and dimensions

- Dimensions of overall building
- Openings of all windows and doors.
- Space allowance for refrigerator and etc.
- Wardrobe depths.
- Location and spacing of all columns and verandah posts.
- Roof and eave lines as dashed lines
- Doors and windows to describing the details of each
- Internal dimensions to establish positions of internal walls or fittings
- Thickness of walls
- Location of fittings and fixtures
- Names on all rooms
- Floor finishes
- Position of stairs and number of stair treads

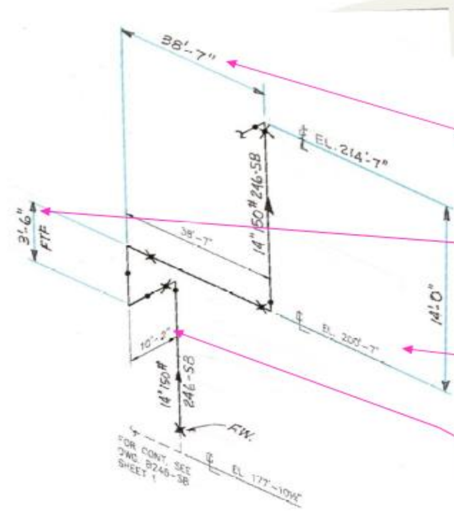
Dimensioning pipe

- Distances from center to center (c to c), center to end (c to e), end to end (e to e) of fittings or valves & the lengths of all straight runs of pipes will be given.
- The size of the pipe for each run is shown by a number or by note at the side of the pipe.



- Pipe length is not normally shown on the drawing, but left to the pipe fitter.
- Pipe & fitting sizes & general notes are places on the drawing beside the part concerned or using a leader.
- Pipe with bends is dimensioned from vertex to vertex.
- Radii & angles of bends should also be dimensioned.
- The outer diameter & wall thickness of the pipe may be specified on the line representing the pipe. [Or on item list, general notes & specification]
- Note should be used to specify the nominal size & type of each fitting & the nominal size of the pipe in each run
- It may be necessary to give overall dimension for other apparatus.

DIMENSIONING PRACTICES:



1. Best way to dimension a pipe is to its centerline at the intersection point
2. Try to keep all dimensions outside the piping view when possible
3. Dimensions should ALWAYS be shown between points in the same plane
4. One of the extension lines of the dimension should be a centerline of the run of pipe
5. Vertical lines of text should always be parallel with extension lines

Self-Check - 3	Written Test

Directions: Write correct or incorrect to obtain measurements and dimensions from plans

1. Roof and eave lines as construction lines
2. Height of walls
3. The inside diameter of the pipe
4. Wall thickness of the pipe

Note: **Satisfactory rating - 2 and 4 points** **Unsatisfactory - below 2 and 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating:

Name: _____________________________ **Date:** _________________

Answer sheet

1. _____ **2.** ______ **3.** ______ **4.** _____

Information Sheet- 4	**Carrying out simple calculations**

4.1 Performing calculations

- **Lengths**

Definition = the standard unit for length is the **meter** (m). For shorter lengths **centimeter** (1m = 100cm) is again subdivided into **millimeters** (1cm = 10mm). For longer distances however, **kilometer** (1000m = 1km) is used.

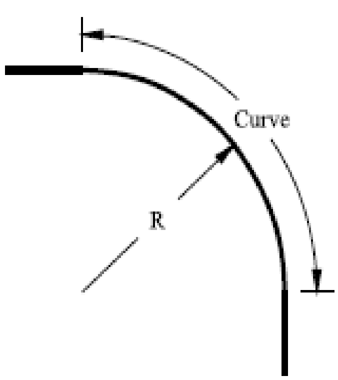
Conversion:

	mm	cm	m	km
1mm	1	0.1	0.001	0.000001
1cm	10	1	0.01	0.00001
1m	1,000	100	1	0.001
1km	1,000,000	10,000	1,000	1

- **Width:** The width of a road, or the layers of a road, is normally given in meters (m).

- **Thickness:** The thickness of a layer in a road, the thickness of the surface or the thickness of concrete work is given in millimeters (mm). (1 000 mm = 1 m)

- **Radius:** Straight sections of a road are joined with curves; the radius (R) of a curve on a road is given in meters (m).

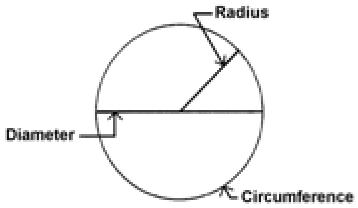


- **Diameter is two times radius**

- **Circle**

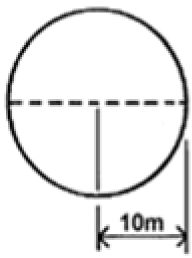
  The circumference of a circle is ð times the diameter. The area of a circle is ð times the square of the radius where ð = 3 1/7 or 3.142

  Area of a Circle



Area of a circle = $ðr^2$
Radius r = 1/2 diameter

Example: Calculate the area and circumference of the given circle:



Radius = 10m
ð = 3.142
Area = $ðr^2$
= 3.142 x 10 x 10
= $314.2m^2$

Circumference of a Circle

Circumference = ð x diameter = ð r^2

Example = 3.142 x 2 x 10
= 62.84m

- **Area**

The unit of measurement for an area is in square meter (m2).

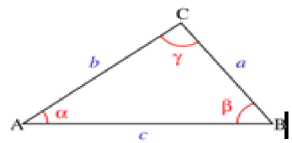
Calculations for areas:

square: a x a	**rectangle: a x b**
triangle: $\frac{a \times h}{2}$	**trapezoid:** $\frac{a + b}{2} \times h$
rhombus: a x h	**circle:** area = $\frac{d^2 \times \pi}{4}$ circumference = d x π

Trigonometric functions

Knowing SAS: Using the labels in the image on the left, the altitude is h = a sin γ. Substituting this in the formula Area = ½bh derived above, the area of the triangle can be expressed as:

$$\text{Area} = \frac{1}{2}ab\sin\gamma = \frac{1}{2}bc\sin\alpha = \frac{1}{2}ca\sin\beta$$



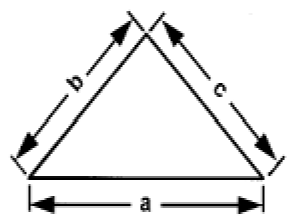
(where α is the interior angle at A, β is the interior angle at B, γ is the interior angle at C and c is the line AB).

Using Heron's Formula

The shape of the triangle is determined by the lengths of the sides alone. Therefore the area can also be derived from the lengths of the sides.

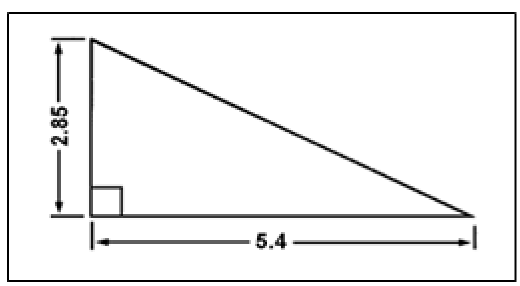
$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

$$s = \frac{a+b+c}{2}$$

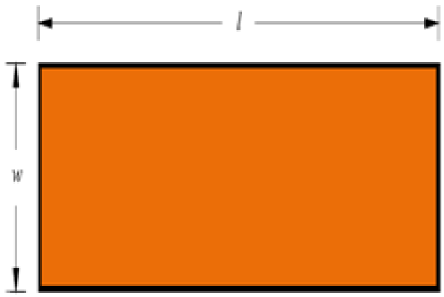


Where is the semi perimeter, or half of the triangle's perimeter.

Example 1 Given base and altitude.
Area = ½ Base x Altitude (0.5 ba)
Or = 0.5 Base x Altitude (0.5 ba)
Base = 5.4
Alt = 2.85
1/2 Base x Alt or 0.5 Base x Alt
½ x 5.4 x 2.85 or 0.5 x 5.4 x 2.85
½ x 15.39 or 0.5 x 15.39m
Area = 7.695m^2 = 7.695m^2



- **Rectangle**

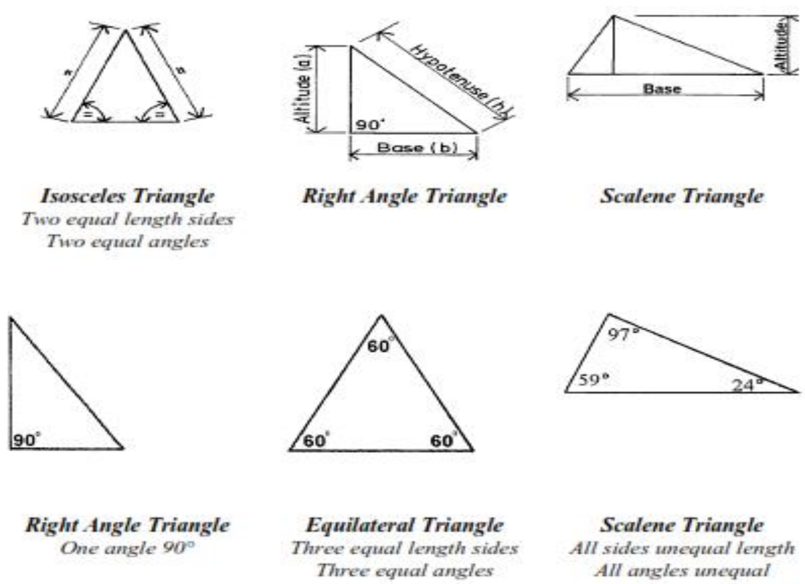


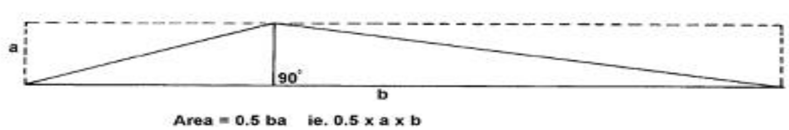
The area of a section of road is normally rectangular in shape and the area is obtained by multiplying the length of the road by the width of the road. The unit used for *l* and *w* must be the same (normally both are expressed in meters (m).

For example: if floor, that is 4m long by 3m wide, is to be compacted, then the area to be compacted is:

5km* 7m or 5000m * 7m = 35000 m^2

- **Triangle**





Notice how the area of a triangle is exactly half that of a rectangle having the same base and altitude.

- **VOLUMES**

Definition = 1m3 is the volume of a cube where each side is 1m. Volumes are calculated by multiplying a base area (m2) with a third dimension.

The calculation of volumes is the most common calculation for road construction work. This is required to develop the bill of quantities, then to measure work for actual construction purposes (estimating resource requirements and time to complete work, material requirements, etc.), and finally to measure the completed work items.

a. Volume of material

The most frequently used unit of measurement for volume is the cubic metre (m^3). This term is mostly encountered in determining the amount of material to be:

- Excavated
- Used in the construction and compaction of a layer
- Carted away

The volume of compacted material in a road layer is obtained by multiplying the thickness of the layer (t) by the width of the layer (w) by the length of the layer (l). The problem here is that the length could be in km, the width in m, and the thickness in mm. They must all be brought to the same unit, normally meters to give a volume in m3 (cubic meters).

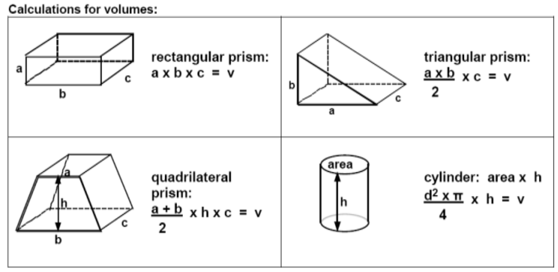
b. Volume of liquids

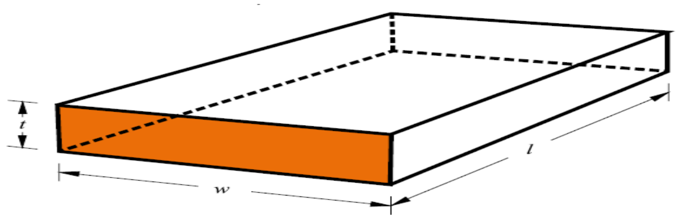
The volume of liquid is normally measured in liters (l). The term is encountered in determining the amount of Water.

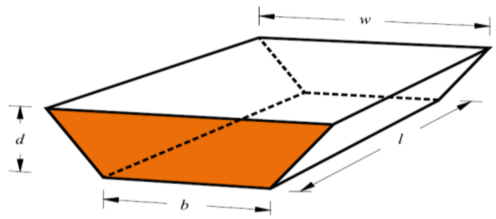
Relationship between the various units of volume:

	cm^3	dm^3 1 litre	m3
$1cm^3$	1	0.001	0.000001
$1dm^3$	1000	1	0.001
$1m^3$	1,000,000	1,000	1

Calculations for volumes:







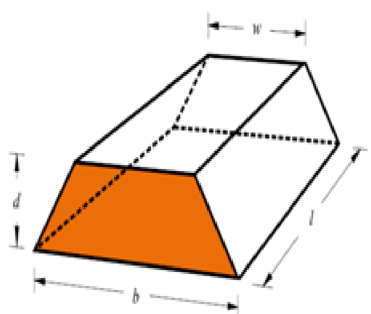
The amount of material to be excavated from a drain of the shape above is:

$$1/2(w + b)\ l \times d$$

Again all the measurements must be brought to the same units, usually meters, giving a volume of material in m3 (cubic meters).

c. Volume of material in a fill or embankment

A fill or embankment is, in effect, an upside down excavation; and the amount of fill material is calculated in the same way as the amount of excavated material.



The amount of material in a fill or embankment of the shape above is: 1/2*(w + b)* lxd

Again all the measurements must be brought to the same units, usually meters, giving a volume of material in m3 (cubic meters).

- **Weight**

Definition = 1 kilogram (kg) is the weight of one cubic decimeter (dm3) or one liter of water with a temperature of 4° C. Other units commonly used in construction are: gram (g) and tone (t).

Relationship between the various units of volume:

	gram	kilogram	tonne
1g	1	0.001	0.000001
1kg	1,000	1	0.001
1t	1,000,000	1000	1

- **Capacity**

Definition= 1 liter of water is the volume of water contained in one cubic decimeter (dm3) at 4°C

$1dm^3$ = 1 litre	$1m^3$ = 1000 litre	1 litre = $0.001m^3$

Relationship between volume, capacity and weight (of water):

$1dm^3$ = 1 litre = 1kg	$1m^3$ = 1000 litre = 1tonne	1 litre = $0.001m^3$ = 0.001tonne

Weight of Water:

$1m^3$ water weight = 1000 kg

$1dm^3$ water weight = 1 kg

1 cm^3 water weight = 1 gram

- **Density**

Definition= weight in kg per m3 volume in normal processed condition of the material

	kg/m^3		kg/m^3
Steel and Iron	7800	Stone for masonry work (dense)	2500-3000
Aluminium	2700	Stone for masonry work (porous)	2200-2500
Copper	8900	Building Sand (natural moisture)	1900-2100
Lead	11,3400	Building Sand (dry)	1800-2000
		Gravel (clean, without fines)	1500-1800
Wood	400 - 800	Cohesive Soil	1800-2000
Hardwood	700-1000	Heavy Clay	1800-2000
Asphalt	1600-2000	Cement or Lime Mortar	1900-2100
Bitumen	1100	Cement (loose)	1200-1400
		Lime (loose)	900-1300
Cement Stone Wall (with mortar)	1800-2000		
Lime Stone Wall (with mortar)	1600-2000	Concrete with reinforcement	2300-2500
Brick Wall (with mortar)	1300-1500		
Masonry wall (with mortar)	2000-2200	*Water*	*1000*

- **Perimeter**

Perimeter is the distance around a two dimensional shape, or the measurement of the distance around something; the length of the boundary. A perimeter is a path that surrounds an area. The word comes from the peri (around) and meter (measure). The term may be used either for the path or its length - it can be thought of as the length of the outline of a shape. The perimeter of a circular area is called circumference.

Basic mathematics

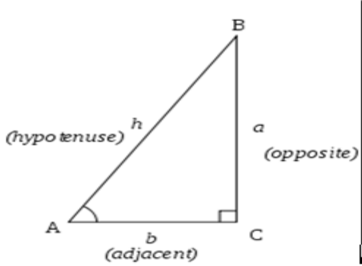
a. Trigonometric ratios

There are various standard methods for calculating the length of a side or the size of an angle. Certain methods are suited to calculating values in a right-angled triangle; more complex methods may be required in other situations.

A right triangle always includes a 90° (π/2 radians) angle, here with label C. Angles A and B may vary. Trigonometric functions specify the relationships among side lengths and interior angles of a right triangle.

In right triangles, the trigonometric ratios of sine, cosine and tangent can be used to find unknown angles and the lengths of unknown sides. The sides of the triangle are known as follows:

- The adjacent side is the side that is in contact with the angle we are interested in and the right angle, hence its name. In this case the adjacent side is **b**.



- The *hypotenuse* is the side opposite the right angle, or defined as the longest side of a right-angled triangle, in this case **h**.
- The *opposite side* is the side opposite to the angle we are interested in, in this case **a**.

The sine of an angle is the ratio of the length of the opposite side to the length of the hypotenuse. In our case

$$\sin A = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{a}{h}\,.$$

Note that this ratio does not depend on the particular right triangle chosen, as long as it contains the angle A, since all those triangles are similar.

The cosine of an angle is the ratio of the length of the adjacent side to the length of the hypotenuse. In our case

$$\cos A = \frac{\text{adjacent side}}{\text{hypotenuse}} = \frac{b}{h}\,.$$

The tangent of an angle is the ratio of the length of the opposite side to the length of the adjacent side. In our case

$$\tan A = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{a}{b} = \frac{\sin A}{\cos A}\,.$$

b. Inverse functions

The inverse trigonometric functions can be used to calculate the internal angles for a right angled triangle with the length of any two sides.

Arc sin can be used to calculate an angle from the length of the opposite side and the length of the hypotenuse

$$\theta = \arcsin\left(\frac{\text{opposite side}}{\text{hypotenuse}}\right)$$

Arc cos can be used to calculate an angle from the length of the adjacent side and the length of the hypotenuse.

$$\theta = \arccos\left(\frac{\text{adjacent side}}{\text{hypotenuse}}\right)$$

Ar ctan can be used to calculate an angle from the length of the opposite side and the length of the adjacent side.

$$\theta = \arctan\left(\frac{\text{opposite side}}{\text{adjacent side}}\right)$$

In introductory geometry and trigonometry courses, the notation $\sin^{-1}$, $\cos^{-1}$, etc., are often used in place of arcsin, arccos, etc. However, the arcsin, arccos, etc., notation is standard in higher mathematics where trigonometric functions are commonly raised to powers, as this avoids confusion between multiplicative inverse and compositional inverse.

b.Sine, Cosine and Tangent Rules

The law of sines, or sine rule, states that the ratio of the length of a side to the sine of its corresponding opposite angle is constant, that is

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}.$$

This ratio is equal to the diameter of the circumscribed circle of the given triangle. Another interpretation of this theorem is that every triangle with angles α, β and γ is similar to a triangle with side lengths equal to sinα, sinβ and sinγ. This triangle can be constructed by first constructing a circle of diameter 1, and inscribing in it two of the angles of the triangle. The length of the sides of that triangle will be sinα, sinβ and sinγ. The side whose length is sinα is opposite to the angle whose measure is α, etc.

The law of cosines, or cosine rule, connects the length of an unknown side of a triangle to the length of the other sides and the angle opposite to the unknown side. As per the law:

For a triangle with length of sides a, b, c and angles of α, β, γ respectively, given two known lengths of a triangle a and b, and the angle between the two known sides γ (or the angle opposite to the unknown side c), to calculate the third side c, the following formula can be used:

$$c^2 = a^2 + b^2 - 2ab\cos(\gamma)$$

$$b^2 = a^2 + c^2 - 2ac\cos(\beta)$$

$$a^2 = b^2 + c^2 - 2bc\cos(\alpha)$$

If the lengths of all three sides of any triangle are known the three angles can be calculated:

$$\alpha = \arccos\left(\frac{b^2 + c^2 - a^2}{2bc}\right)$$

$$\beta = \arccos\left(\frac{a^2 + c^2 - b^2}{2ac}\right)$$

$$\gamma = \arccos\left(\frac{a^2 + b^2 - c^2}{2ab}\right)$$

The law of tangents or tangent rule, is less known than the other two. It states that:

$$\frac{a-b}{a+b} = \frac{\tan[\frac{1}{2}(\alpha - \beta)]}{\tan[\frac{1}{2}(\alpha + \beta)]}.$$

It is not used very often, but can be used to find a side or an angle when you know two sides and an angle or two angles and a side.

c. **Algebraic computations**

The Pythagorean Theorem: The sum of the areas of the two squares on the legs (a and b) equals the area of the square on the hypotenuse (c). The Pythagorean equation provides a simple relation among the three sides of a right triangle so that if the lengths of any two sides are known, the length of the third side can be found. Another corollary of the theorem is that in any right triangle, the hypotenuse is greater than any one of the legs, but less than the sum of them.

The theorem can be written as an equation relating the lengths of the sides a, b and c, often called the Pythagorean equation:

$$a^2 + b^2 = c^2$$

Where c represents the length of the hypotenuse, and a and b represent the lengths of the other two sides.

If the length of both a and b is known, then c can be calculated as follows:

$$c = \sqrt{a^2 + b^2}.$$

If the length of hypotenuse c and one leg (a orb) are known, the length of the other leg can be calculated with the following equations:

$$a = \sqrt{c^2 - b^2}.$$ or

$$b = \sqrt{c^2 - a^2}.$$

d. Fractions

If there are 2 oranges and 3 apples, the ratio of oranges to apples is 2:3, whereas the fraction of oranges to the total fruit is 2/5.

If orange juice concentrate is to be diluted with water in the ratio 1:4, then one part of concentrate is mixed with four parts of water, giving five parts total; the fraction of concentrate is 1/5 and the fraction of water is 4/5.

Number of Terms, In general, when comparing the quantities of a two-quantity ratio, this can be expressed as a fraction derived from the ratio. For example, in a ratio of 2:3, the amount/size/volume/number of the first quantity will be $\frac{2}{3}$ that of the second quantity. This pattern also works with ratios with more than two terms. However, a ratio with more than two terms cannot be completely converted into a single fraction; a single fraction represents only one part of the ratio since a fraction can only compare two numbers. If the ratio deals with objects or amounts of objects, this is often expressed as "for every two parts of the first quantity there are three parts of the second quantity".

e. Percentages

Percent (%) means out of 100. For example, 10% means 10 out of 100. To find a percentage of a number, multiply the number by the percent and divide by 100. For example: 20% of 300.00 Birr = 300.00 Birr x 20/100 = 60.00 Birr

Using a percentage

- To add on GST

Gross service tax(GST) of 10% needs to be added to the cost of all goods and services.

For example: How to do it direct labor costs for 4 hours work with rate of 30.00Birr/hour

4 * 30 Birr = 120.00Birr

GST on these labor costs = 10% of 120.00 Birr = 120.00Birr x 10 ÷100 = 12.00Birr

So direct labor costs including GST = 120.00 Birr + 12.00Birr = 132.00 Birr

- To add on additional costs

Profit might be charged at 15% of labor and material costs.

For example: Labor and material costs = 370.00 Birr

Profit = 15% of 370.00Birr

= 370.00Birr x 15/100

= 55.50Birr

Now add this to the labor and material costs:

= 370.00 Birr + 55.50Birr

= 425.50 Birr

- To take off a discount

Discount of 5% might be offered to a client for prompt payment. Work out the amount of the discount, then subtract it from the price.

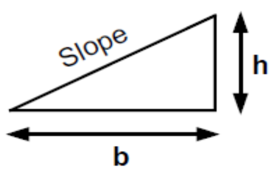
For example: Cost to client = 425.50Birr

5% discount = 425.50Birr x 5/100 = 21.28Birr

So cost after discount = 425.50Birr - 21.28Birr = 404.2Birr

SLOPES (as ratio and percentage)

Definition = the slope shows the steepness of an ascent or descent.



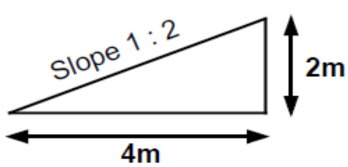
h = vertical distance
b = base = horizontal distance

$$\text{Slope} = \frac{\text{vertical distance}}{\text{horizontal distance}}$$

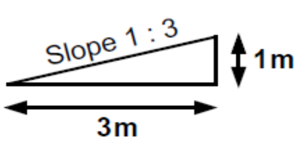
Slope calculation = slopes can be expressed as a ratio or in percentage.

Slope given as a **ratio:**

Examples



$$\text{Slope} = \frac{\text{vertical distance}}{\text{horizontal distance}} = \frac{2}{4} = \frac{1}{2} = \mathbf{1 : 2}$$



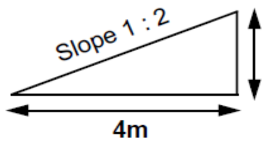
$$\text{Slope} = \frac{\text{vertical distance}}{\text{horizontal distance}} = \frac{1}{3} = \mathbf{1 : 3}$$

Note:

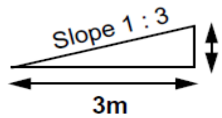
- The figure on top should always be the vertical distance and the figure below should always be the horizontal distance.

Slope given in **percentage (%):**
Any fraction (ratio) can be expressed in % by dividing the result by 100%.

Examples



$$\text{Slope} = \frac{\text{vertical distance}}{\text{horizontal distance}} \times 100\% = \frac{2}{4} \times 100\% = \mathbf{50\%}$$



$$\text{Slope} = \frac{\text{vertical distance}}{\text{horizontal distance}} \times 100\% = \frac{2}{3} \times 100\% = \mathbf{33.33...\%}$$

Formulas:

slope = height / base
height = base x slope
base = height / slope

PRESSURE

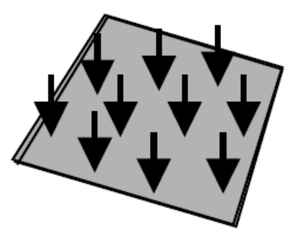
Pressure is defined as the distributed force (F) acting on an area (A). The standard unit for pressure is Pasqual (Pa)

Pressure:

$$P = \frac{\text{Force}}{\text{Area}} \qquad \frac{F}{A}$$

F is measured in Newton (N)

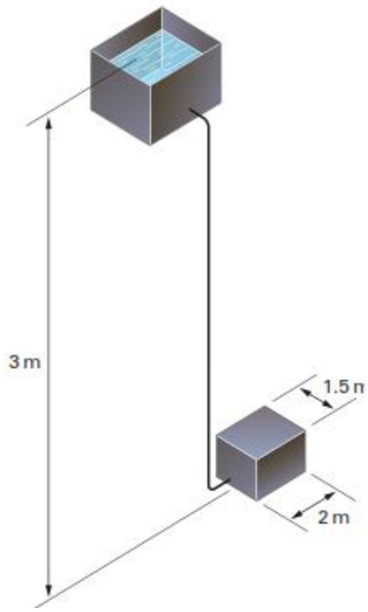
A is usually measured in m^2 or in cm^2



However, force measured in Newton is not a value we easily recognize in daily life. To fact that one liter (or 1000 cm3) of Water weighs 1kg. Hence a 10 meter water column produces a force of 1kg per every cm^2.

Intensity of pressure and total pressure

Intensity of pressure is the force created (kPa) by the weight of a given mass of water acting on a unit area (m2). Total pressure is the intensity of pressure multiplied by the area acted on.



Example 1:

Calculate the intensity of pressure and total pressure acting on the base of the lower cistern.

$$\begin{aligned}\text{Intensity of pressure} &= \text{head} \times 9.81 \text{ kPa} \\ &= 3 \times 9.81 \\ &= 29.43 \text{ kPa/m}^2 \text{ or approximately 0.3 bar pressure.}\end{aligned}$$

An alternative method of calculating this is to multiply the head × 0.1 bar (0.1 bar = 1m head) = 3 × 0.1 bar = 0.3 bar pressure.

$$\begin{aligned}\text{Total pressure} &= \text{intensity of pressure} \times \text{area of base} \\ &= 29.43 \times (2 \times 1.5) \\ &= 88.29\text{kPa}\end{aligned}$$

Example 2:

If a tap is sited 5 metres below a plumbing cistern feeding it, the pressure created at the tap will be

5.0 metres head × 0.1 bar pressure = 0.5 bar

Specific heat capacity

To size various plumbing components, such as boilers and radiators, plumbers need to be able to understand the concept of heat. Heat is different from temperature. Heat is a measure of the amount of energy in a substance. The standard unit of measurement of heat is **the joule**.

In order to work out the amount of heat required to heat a substance we need to be able to measure the amount of heat required over time or the **power** required. This is a measure of the energy divided by the time/time taken to heat the substance measured in kW/hrs.

$$1 \text{ kW/hr} = \frac{1000 \text{ joules}}{1 \text{ second}} \times 3{,}600 \text{ seconds (number of seconds in one minute)}$$

In order to be able to undertake plumbing calculations involving heat we usually need to be able to work out the amount of heat required to raise a quantity of a substance such as water from one particular temperature to another. To do this we need to know the substance's **specific heat capacity**.

The specific heat capacity of a substance is the amount of heat required to raise 1kg of a substance by 1°C. The specific heat capacity of water is 4.186 kJ/kg/°C.

Example:

Calculate the heat energy and power required to raise 200 litres of water from 10°C to 60°C (assume 1 litre of water to roughly weighs 1kg).

$$\text{Heat energy} = 200 \text{ litres} \times 4.186 \text{ kJ/kg/°C} \times (60°C - 10°C)$$
$$= 41{,}860\text{kJ}$$

Power required to heat the water in 1 hour (assuming no energy is lost)

$$= \frac{41{,}860}{3600} = 11.63\text{kW}$$

The power calculation is essential in determining factors such as the amount of energy required to re-heat a hot water storage cylinder against a specific period of time. For example had the water required to be reheated in a 30 minute time period in our example power calculation, then the power required would be double as the re-heating period has been halved (from 3,600 seconds to 1,800 seconds).

$$= \frac{41{,}860}{1800} = 23.26\text{Kw}$$

conversion

TEMPERATURE: $^0F = (^0C \times 9/5) + 32$ $9/5 = 1.8$

$^0C = (^0F - 32) \times 5/9$ $5/9 = .555$

Perimeter The perimeter is the total length of the sides or outer boundary of a plane figure.

Example The perimeter of a shape is the total length of the sides. Refer to Figure below. The perimeter of this building is the total length of ALL the sides.

6000 + 10 000 + 4 000 + 4 000 + 2000 + 6 000

Perimeter = 32 000

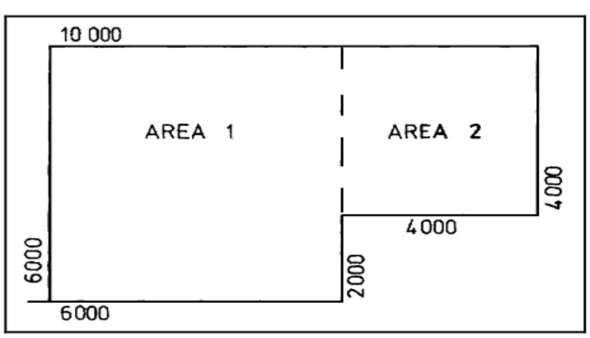


Figure : Plan Of An L-Shaped Building

Area

Area is the extent of a surface or the amount of ground covered by a building. Area is measured in square meters and in the case of a rectangular shape is found by multiplying the length by the breadth (or depth) of the building. Refer to Figure 6. Because this is an L shaped building you must first divide it into two simple rectangles. See the dotted line.

For general use area is always given in m therefore it is easier if you convert the dimensions into meters prior to calculating the area.

ie 6 000 = 6.0

10 000 = 10.0

4 000 = 4.0

Area 1 = 6.0 x 6.0 = 36m

Area 2 = 4.0 x 4.0 = 16m

Total Area = 36 +16 = 52m

Self-Check - 4	Written Test

Directions: Answer the question accordingly.

Question 1. Write the following in descending order.

0.4   0.04   0.004   0.44   40.00   04.40

Question 2. Write the decimal number between 0.30 and 0.50.

Question 3. Convert the following units

a. 12kg to grams

b. 120cm to meter

c. 1150 ml to liters

d. 1050 kg to to kilogram

e. 13m to millimeter

f. 5.58 liter to milliliter

g. 20^0C to degree ferahenit

Question 4. If right angle triangle side a is 3m and side b is 30cm. What is the length of the diagonal side c that need to be cut.

Question 5. If side a is 1m and side b and c are 4and 3m respectively. What is the perimeter of the triangle.

Question 6.

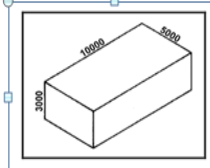


Figure : Pictorial View

Calculate the amount of air space occupied by a building or part thereof and is found by multiplying the length by the breadth by the height of the building or object. Example on Figure

Volume = 10.0 x 5.0 x 3.0

Volume = $150m^3$

Question 7. If side a, b and c length are 4m, 90cm and 440mm. What is the area of the triangle.

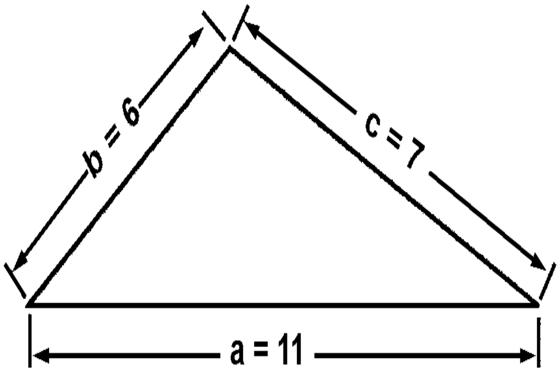
Question 8. If diameter of a circle is 9cm.what are the area, circumference and radius of the circle.

Question 9. If vertical difference is 50cm and horizontal difference 10000mm.calculate the slope and in percent slope.

Question 10. Calculate the heat energy and power required to raise $1000cm^3$ of water from 10^0C to 60^0C.

Question 11. If the material cost is 2000Birr and the labour cost is 30% of material cost and overhead cost is 10% of material cost. Calculate total cost.

Question 12. Calculate the area of the triangle given below.



Question 13. If the angle between two sides of the above triangle is 20^0 then calculate two other angle of the triangle above.

Question 14. If income is 24000 Birr and Profit before tax is 4000Birr. Calculate the expense cost and Net profit including 10% income tax.

Note: **Satisfactory rating - 6 and 12 points** **Unsatisfactory - below 6 and 12 points**

You can ask you teacher for the copy of the correct answers.

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Answer sheet

1. _____ 2. ____________ 9. _________

3. _a. _______ 4. __________ 10. _________

b. _______ 5. _______ 11. _________

c. _______ 6. ______ 12. ____

d. _______ 7. _______

e. _______ 8. _______

f. _______

g. ________

Operation Sheet 1	Carrying out simple calculations

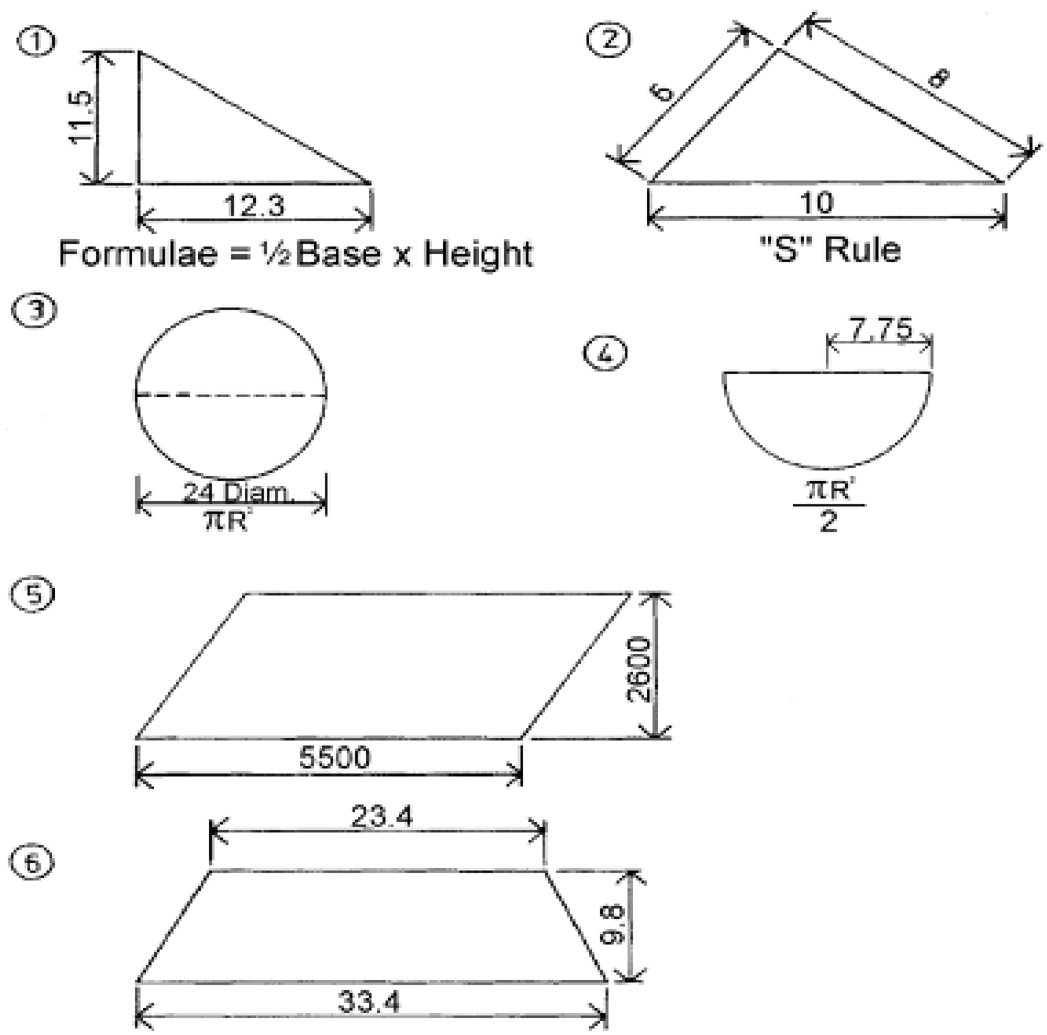
The techniques for carrying out simple calculations are;

Task 1. Identify typical figure given below

Task 2. Refer the reading materials carefully

Task 3. Relate the figure with the formula given above.

Task 4 Calculate the area of the given shapes 1 to 6.



Operation Sheet 2	**Carrying out simple** calculations

Techniques for Carrying out simple calculations are:

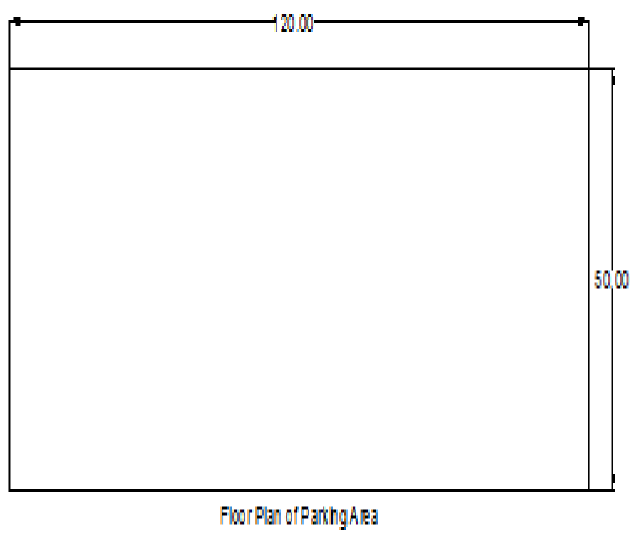
Task 1. Identify typical figure given below

Task 2. Refer the reading the problem carefully

Task 3. Relate the figure with the standard formulas given above.

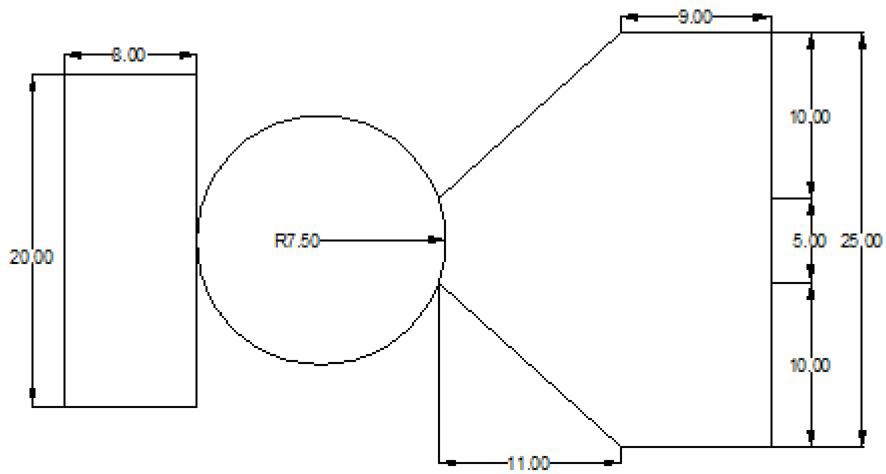
Task 4 answer appropriate required materials of the given question 1 to 3.

1. By the area method, determine the quantity of cement, sand, and gravel of the proposed concrete parking area 6 inches thick with general dimensions of 50 meters x 120 meters using class mixture 40 kg cement. All measurement shown in the figure is in meter unit.



Drawing 1

2. By the volume and area method, find the quantity of cement, sand, and gravel of the concrete pavement 4” thick using class “b” concrete 40kg cement. All measurement shown in the figure is in meter unit.



Concrete Pavement Plan

Drawing 2

3. From the following given figure, solve for the quantity of cement, sand, and gravel by the volume method using 40 kg cement (a) class “a” concrete; (b) class b concrete. All measurement shown in the figures in meter unit.

a. 6 column @ 4.0 m high

b. 8 column @ 6.0 m high

4. A one store building with six (6) rectangular columns 0.20 m x 0.25 m and its foundation 1.0 m x 1.0 m. estimate the concrete materials of column and foundation using 40kg cement class “a” concrete. all measurement shown in the figure is in meter unit

LAP Test	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: _________________________ Time finished: _________________

Instructions: Given necessary drawings, specifications, templates, tools and materials you are required to perform the following tasks within 4 hours.

Task 1: Select plumbing plan and elevations with its specification (this is done before practical demonstration day).

Task 2: Identify plumbing work in the drawing and specification.

Task 3: identify plumbing work measurements.

Task 4. Apply quality requirement of calculations

Task 5 Identify plumbing work dimensions

Task 6 Carry out simple calculations for plumbing work

List of Reference Materials

1. Seeley IH. (1998). *Building Quantities Explained* 5th Revised edition, Macmillan ISBN 978-0-333-71972-5
2. Seeley IH. (1997). *Quantity Surveying Practice*, 2nd Revised Macmillan; ISBN 978-0-333-68907-3
3. Lee S. Trench W. Willis A. (2005) *Elements of Quantity Surveying*. 10th Edition WileyBlackwell; ISBN 978-1-4051-2563-5
4. Ashworth A. Hogg K. (2007). *Willis's Elements of Quantity Surveying* 12 Rev Ed edition Blackwell Publishing. ISBN 978-1-4051-4578-7