National Certificate in Building, Construction and Allied Trades Skills (BCATS)

Apply mathematical processes to BCATS projects

Unit Standard – 24361

Level 2, Credit 3

Name:

Contents

Reference *Page*

Published by: Building and Construction Industry Training Organisation (BCITO)
Level 5, 234 Wakefield Street
PO Box 2615
Wellington

What you need to do

You need to show your teacher/tutor that you can:

- identify what information you want to find;
- choose a suitable mathematical method that combines **2** mathematical skills (numerical calculation, measurement, geometry or trigonometry). Numerical calculations may include: addition, subtraction, multiplication, division, converting fractions to decimals and percentages and vice versa, square, square root, using formulae to calculate area and volume. Calculators and computers may be used in achievement of credit for this unit standard;
- use the method to produce a solution that is accurate and appropriate; and
- choose a suitable method to communicate the solution. You need to produce **3** different methods (cutting list, job sheet, diagram).

How you will be assessed

You must document the practical use of mathematical processes for **2** construction projects. These projects can be:

- those that you work on through out the year OR
- come from the worksheet that your teacher will provide OR
- a combination of the two as long as you cover a total of 2 projects.

If you use the worksheet for assessment, your teacher/tutor will provide it and mark it for you.

Glossary of Terms

Term	Meaning
π (pi)	3.142
Area of a circle	πr^2 (3.142 x radius^2)
Area of a rectangle	Length x width
Area of a triangle	Half x base x height
Capacity	Volume
Circumference	The distance around the edge of a circle: π x diameter of the circle
Diameter	Distance across a circle at the widest point
Dimension	Measurable distance
g	Gram(s)
ha	Hectare(s)
kg	Kilogram(s)
l	Litre(s)
m	Metre(s)
m^2	Metres squared or square metres (length x width)
m^3	Metres cubed or cubic metres (length x width x height)
mm	Millimetre(s) – one-thousandth of a metre
Overall measurement (O/A)	The total of the individual measurements
Perimeter	The distance around an object or figure; the total measurement of all its sides 2 x (length + width)
Radius	Distance from the centre of a circle to the edge; half the diameter
Running measurement	The sum of individual measurements from a given point
Volume of a cube	Length x width x height (or area of cross section x length)
Volume of a cylinder	πr^2 x h

Introduction

Calculations are an integral and essential part of modern industry. Without an understanding of a range of mathematical principles, timber components would not be cut to the correct lengths, quantities of materials would be over or under ordered, windows and doors would be made to the wrong size and kitchen cabinets would not fit in the spaces provided.

This module will cover step by step a range of mathematical processes that will provide a basic knowledge for trade-related calculations.

The importance of taking the opportunity to gain this knowledge before leaving school cannot be over emphasised.

The Basics – Beating the calculator

Being able to visualise numbers is a skill that will save a lot of time and frustration.

You can quickly check and confirm measurements and identify faults before they happen.

Linking mathematical skills to measuring and workplace calculations will improve your accuracy and efficiency.

You will be more confident, make fewer mistakes and be more valued as an employee for your skills.

Activity 1

Work out the following problems without the use of a calculator.

Addition

Answer the following problems without the use of your calculator.

1.	15 + 75	2.	37 + 15
3.	12 + 64 + 5	4.	28 + 42 + 83
5.	2.1 + 1.3	6.	2.6 + 3.9
7.	13.8 + 14.23 + 8.1	8.	0.003 + 1.742

Subtraction

Answer the following problems without the use of your calculator.

9.	48 – 35	10.	135 – 98
11.	1765 – 876	12.	6.3 – 2
13.	22.4 – 15.2	14.	124 – 45.6
15.	8.3 – 4.2	16.	7.8 – 0.03

Multiplication

Answer the following problems without the use of your calculator. Confirm your answer with your calculator.

17.	7 x 6	18.	19 x 8
19.	64 x 13	20.	21.3 x 4
21.	32 x 6.2	22.	27.2 x 5.3
23.	15 x 0.045	24.	936.2 x 0.03

Division

Answer the following questions without the use of you calculator. Confirm your answer with a calculator.

25.	18 ÷ 3	26.	25 ÷ 2
27.	37 ÷ 3	28.	2.4 ÷ 2
29.	524 ÷ 20	30.	756 ÷ 15

Linear Measurement Systems

Linear measurement

Length, distance, width, height, depth, dimension – what's the difference?

- **Length** is used for shorter measurements, e.g. the length of timber is 600 millimetres.
- **Distance** is used for longer measurements, e.g. the distance to town is 2.5 kilometres.
- **Width, height and depth** are also different ways to talk about length. We use these terms when we measure area and volume.
- **Dimension** is another word for measurement – for example, you might talk about the dimensions on a plan rather than the lengths or measurements.
- Length is usually measured in a straight line, especially shorter lengths which need to be very accurate. Distances may not be straight lines, e.g. a road or a race track.

Units of measurement

In industry, linear measurements are defined in millimetres (mm) and metres (m).

- 1 metre = 1000 millimetres.
- Centimetres are not used.
- Construction drawings are usually dimensioned in millimetres unless otherwise stated.

The dimension can be recorded in one of the following ways:

- 1m;
- 1.000m; or
- 1000mm

A millimetre is 1/1000 or one 1000th of a metre and can be recorded in the following ways:

8mm	=	0.008m	or	.008	or	8mm	or	8
56mm	=	0.056m	or	.056	or	56mm	or	56
752mm	=	0.752m	or	.752	or	752mm	or	752

Tapes and rules are the most commonly used tools for measuring lengths.

- A tape is more accurate than a rule when measuring distances over 1 metre.
- A steel or folding rule is easier to use and more accurate for marking out short lengths of less than 1 metre.
- Vernier callipers can offer accurate measurements to very fine tolerances. These are commonly used for precision manufacturing and machining operations. General

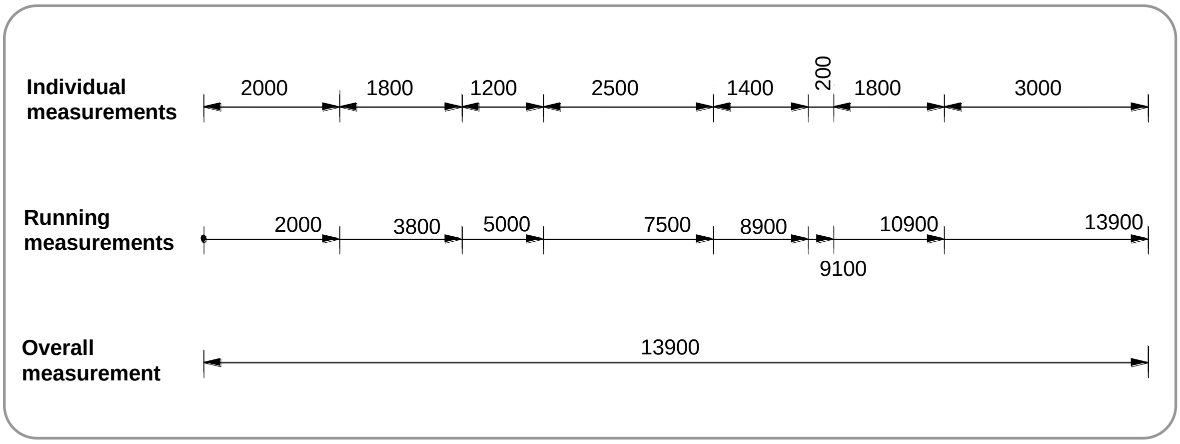
analog vernier callipers can measure with the minimum unit of 1/20 mm. Digital vernier callipers can measure with the minimum unit of 1/100 mm.

Types of measurement

There are three types of measurements commonly used in construction:

- individual;
- running; and
- overall.

Below is an example of each type.



Dimensions on working drawings are usually shown as individual and overall measurements. When running measurements are required, then the dimensions will need to be added together.

Running measurements (particularly for set-outs) eliminate cumulative error. Cumulative error is the error made by adding successive additions, e.g. setting out room by room individually and not using running/overall measurement.

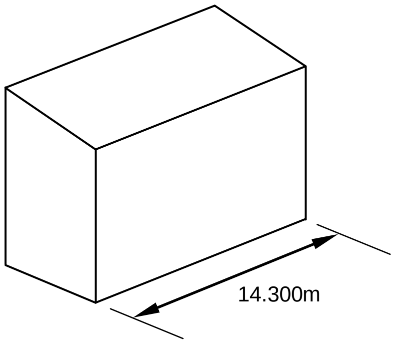
Overall measurements

Overall measurements are the sum total of the individual or running measurements.

Overall measurements are used in:

- setting out;
- checking accuracy of individual set-outs;
- calculating area (m^2) or cubic measures (m^3); and
- calculating quantities, such as the number of floor joists or studs required, or the number of sheets of roofing material required.

Example: Calculate the number of sheets of roofing iron for a lean-to roof with a length of 14.300m. The effective coverage of one sheet is 0.760m.



Number of sheets required $= \dfrac{\text{Length of roof}}{\text{Effective coverage}}$

Number of sheets required $= \dfrac{14.300\text{m}}{0.760\text{m}}$

Actual number required **18.8 sheets**

Round up the total of actual sheets required to obtain the final number of complete sheets that would need to be ordered = 19 sheets.

Individual measurements

An individual measurement is the distance between two fixed points. Examples where individual measurements are used include:

- partition walls;
- opening positions;
- opening heights and widths;
- roof truss spacings; and
- purlin spacings.

Running measurements

Running measurements are the sum of individual measurements from a given point.

Advantages of using this method are:

- set-out time can be reduced; and
- all measurements are taken from a single point, reducing the possibility of error.

Running measurements are not generally found on plans; they need to be calculated.

Spacing for framing members

The requirement to equally space or set out framing members is a commonly used skill within the construction and manufacturing industries. Correct and accurate setting out of a job will ensure that the construction operation flows in an efficient manner.

There are four principles involved in the equal spacing of framing members.

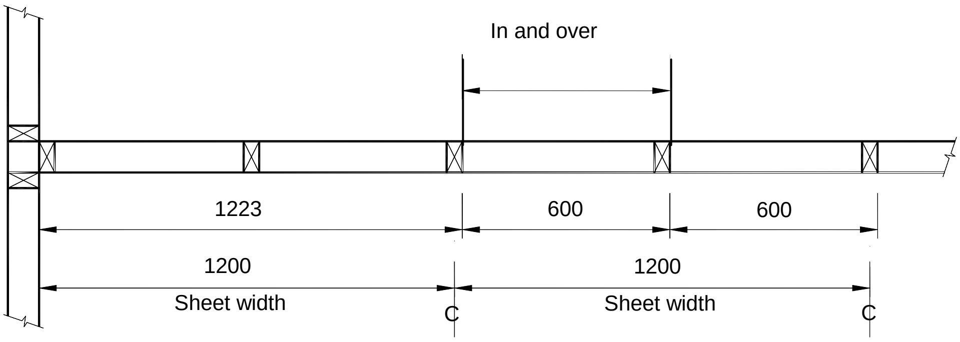
- one for nothing;
- in and over;
- centre to centre ; and
- in between.

While each method has its own specific meaning and application they are all related in their application.

- The sample below shows an example of a wall 3000mm long that requires studs with a maximum spacing of 600mm to be evenly spaced along its length.
- Note that there are five spacings with a framing member associated to it but six framing members are required – the calculations are based around the spacings.
- The drawing is using the principles of the **In and Over** measurement.

In and over to suit sheets (vertical fixing)

The in and over method can be used for setting out to suit a standard sheet width, so the joint of the sheet is in the centre of the stud. The first joining stud is measured from the adjacent wall, the width of the sheet plus half the stud thickness. From then on, the in and over measurement of 600 applies. This will automatically space the studs so that a 1200mm wide sheet will join on the centre of a stud. (This is illustrated below.)

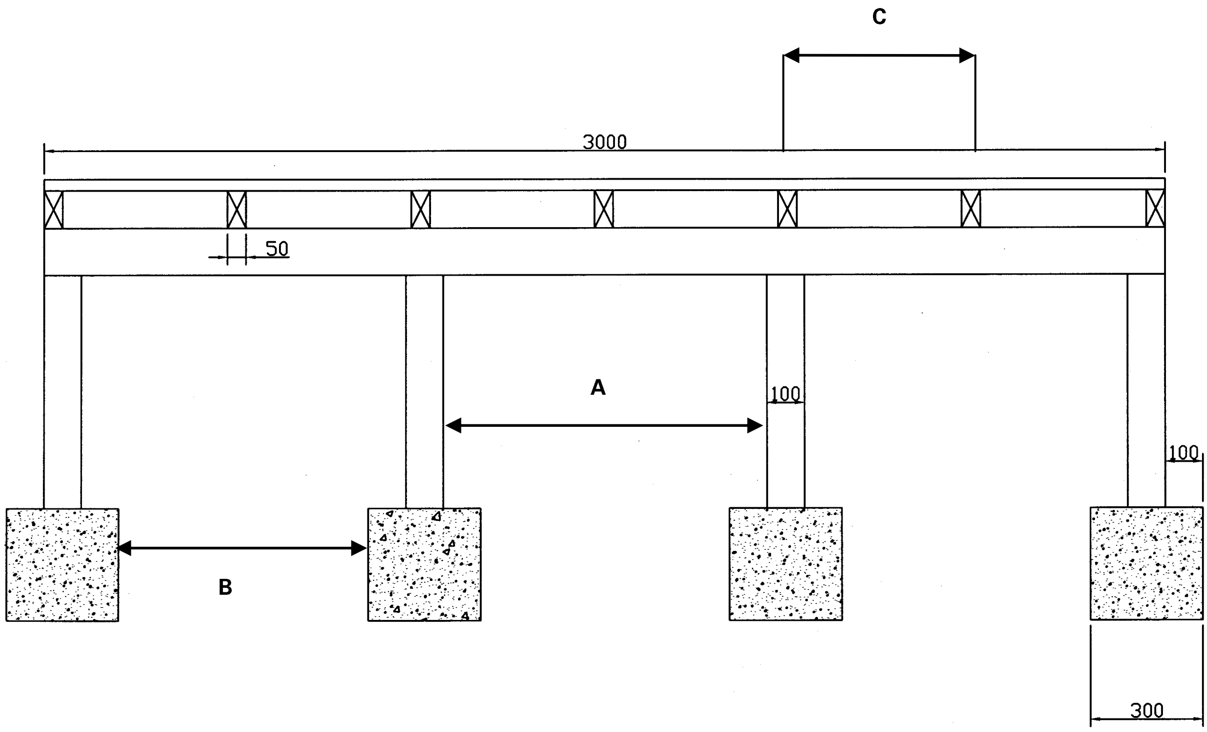


Centre to centre

The centre to centre dimensions are normally recorded in the specification documents or in the working drawings.

The measurement is referring to the distance from the centre of one member to the next member.

Activity 2



1. **a)** A deck needs to be constructed. (See sketch above.) The length of the deck is 3 metres. The foundation piles are 100 x 100 H4 radiata pine mounted in 300 x 300 concrete footings. Four are to be evenly spaced along its length. Calculate the spacings (Distance A on the sketch).

Method used: Answer =

b) You are preparing to dig out the footings. They are 300 x 300mm. Calculate the distance between the holes (Distance B on the sketch).

Answer =

c) Seven joists need to be equally spaced along the bearer. Calculate the distance between centres for the joists to be positioned (Distance C on the sketch).

Answer =

2. Complete the table below by converting the dimensions in the left column into millimetres and metres.

	Number	millimetres	metres
a.	*Example 5cm*	*50*	*.05*
b.	75 mm		
c.	25 cm		
d.	1.3 m		
e.	126 cm		
f.	5 mm		
g.	3800 mm		
h.	1390mm		
i.	.05 m		
j.	.8 m		
k.	.001 m		
l.	109500 mm		
m.	324 cm		
n.	.4 cm		
o.	5.600m		

3. A path measures 750mm wide x 75mm thick x 5.5m long. Express all of the dimensions as metres.

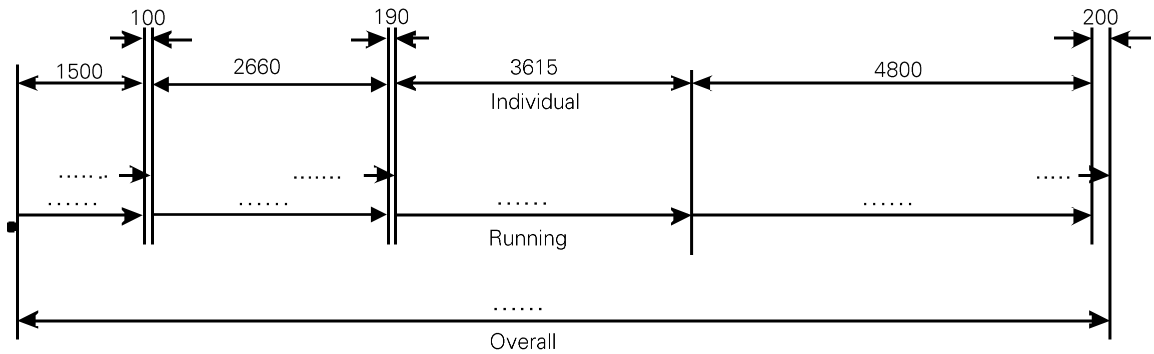
x x

4. Select the most suitable measuring tool and record the following dimensions in both millimetres and metres.

	Millimetres	Metres
Height of a door		
Thickness of a door		
Length of a wall		
Height of a desk		

5. The length of a fence is 24 metres. The posts are to be spaced 2 metres apart. How many posts do you need to order?

6. Using the series of individual measurements from a building plan detailed below, calculate the dimension of the running and the overall measurements, where indicated.



7. On the following page, make a sketch of the outside of a classroom or building. Measure the building and dimension the sketch using:

- individual measurements;
- running measurements; and
- total up the individual dimensions and compare the answer with the overall measurement.

Classroom or building sketch

8. Describe the benefits of using running measurements.

Geometry

The word geometry is derived from two Greek words meaning "earth measurement". It also includes the measurement of lines, plane surfaces and solids.

Geometry came from Ancient Egypt where it was necessary to have a method of land survey to re-establish land boundaries following the frequent flooding of the Nile River.

Perimeters

The perimeter is the lineal distance around the outside of a given shape. The length of perimeters is often used to calculate the quantities of cladding and finishing materials.

Lengths along straight lines are easy to calculate. Simply measure the lengths and then add them together.

To find the perimeters of a:

Square

- Perimeter of a square = multiply the length of one side by 4

Rectangle

- Perimeter of a rectangle = multiply the length + width by 2

Circle

- Perimeter of a circle = π x diameter

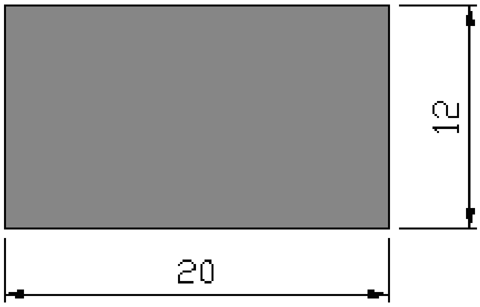
Triangle

- Perimeter of a triangle = length of side 1 + length of side 2 + length of side 3

Activity 3

Calculate the following perimeters

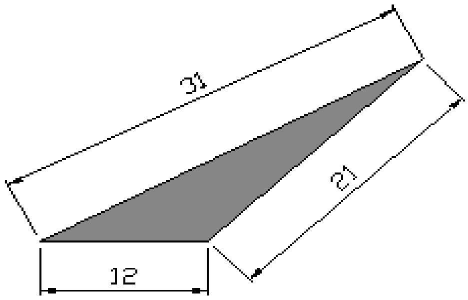
1. Rectangle:



Formula:

Answer:

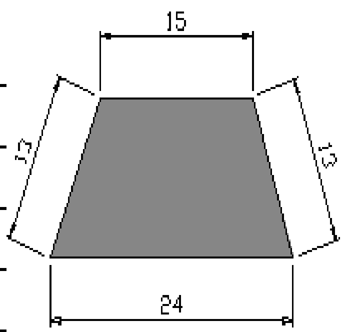
2. Irregular triangle:



Formula:

Answer:

3. Trapezium:



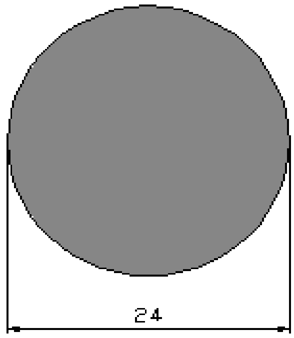
Formula:

Answer:

4. Circle:

Formula:

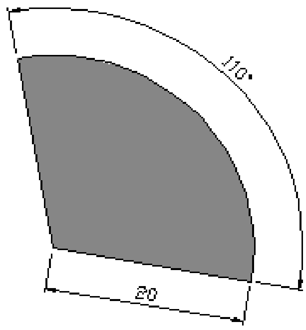
Answer:



5. Sector:

Formula:

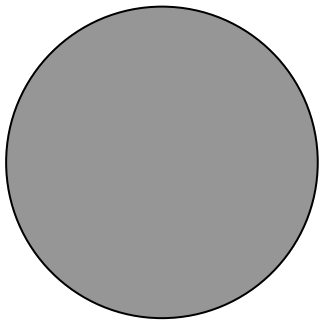
Answer:



6. Circumference of a circle: Diameter 8m.

Formula:

Answer:



Area

Area is the amount of a surface covered. It is expressed in units squared (e.g. metres^2 or m^2).

The calculation of area has many applications in the building trade. It is useful for calculating material requirements, areas of building coverage and also for pricing.

Units of area

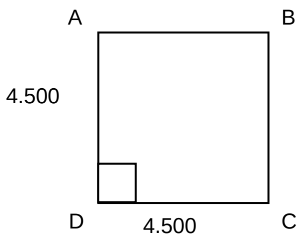
The square metre is the basic unit of area. One square metre is the area taken up by a square that is 1 metre long and 1 metre wide. This is usually written as 1 sq m or 1m^2. (You write the 2 above the "m" symbol.)

Area can be measured in:

- square centimetres (cm^2);
- square metres (m^2);
- hectares (ha) – these are used to measure an area of land; or
- square kilometres (km^2).

Area of a square

Example: Calculate the area of a square by multiplying the length of one side by itself.

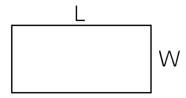


Area of square ABCD	=	4.5^2
	=	4.500 x 4.500
Area	=	**20.25m^2**

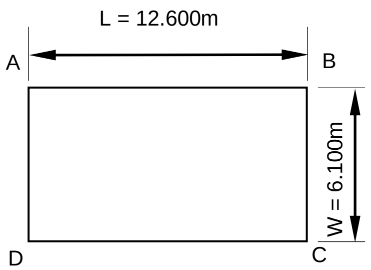
Area of a rectangle

The area of a rectangle can be calculated using the following formula:

Area of rectangle = Length (L) x Width (W)

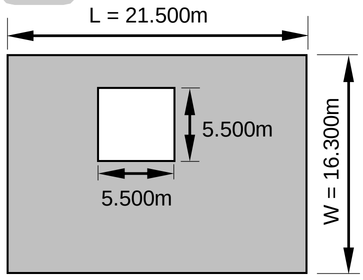


Example 1: Calculate the area of the rectangle ABCD, where A to B = 12.600m and B to C = 6.100m.



Area of rectangle	=	Length (L) x Width (W)
Area of ABCD	=	12.600 x 6.100
	=	**$76.86m^2$**

Example 2: Calculate the shaded area of a building site.

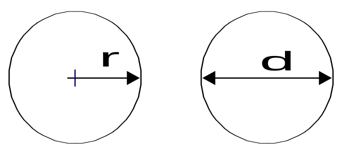


Shaded area	=	Area of rectangle – Area of square
	=	(L x W) – (Area of square)
	=	(21.5 x 16.3) – (5.5 x 5.5)
	=	350.450 – 30.250
Shaded area	=	**$320.2m^2$**

Area of a circle

The area of a circle can be found by multiplying the square of the radius (half the diameter) by π (3.1412).

Area of a circle = πr^2



Example: Calculate the area of a circle with a diameter of 2.800m.

Note: *Radius (r) is half the diameter (d) (d = 2r).*

Area of circle	=	πr^2
	=	$3.142 \times r^2$
Radius (r)	=	$\frac{\text{Diameter}}{2}$
	=	$\frac{2.800}{2}$
Radius	=	1.400m
Area of circle	=	3.142×1.400^2
		3.142×1.960
Area of circle	=	**6.1575m²**

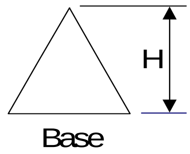
Area of a Triangle

The area of a triangle is found by using the following formula:

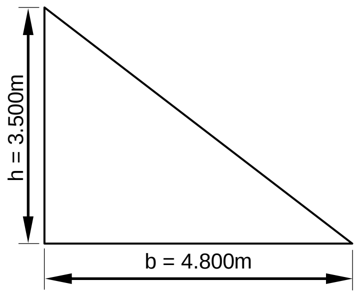
Area of a triangle = half of the base distance x vertical height or it is often shown in abbreviated forms such as:

Area of a triangle = ½ b (base) x h (height) or

Area of a triangle = 0.5 x b x h



Example: Calculate the area of a triangle where the base is 4.800m and the vertical height is 3.500m.

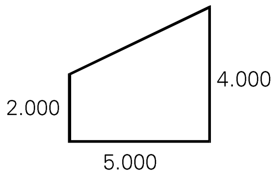


Area of triangle	=	0.5 x b x h
	=	(0.500 x 4.800) x 3.500
Area of triangle	=	**8.40m²**

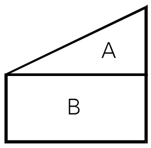
Area of irregular figures

The area of an irregular figure can usually be calculated by adding together the areas of the "regular" figures that form it. By drawing lines within the irregular figure, squares, rectangles and triangles can be made, and their individual areas calculated.

Example 1: Calculate the area of the following shape.

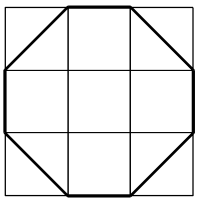


Area of triangle (A)	=	0.5 x b x h
	=	(0.500 x 5.000) x 2.000
	=	**5.0m^2**
Area of rectangle (B)	=	L x W
	=	5.000 x 2.000
	=	**10.0m^2**
Area of shape (A + B)	=	Area (A) + Area (B)
	=	5.0 + 10.0
Area of shape	=	**15.0m^2**



This shape is made up of a triangle (A) and a rectangle (B).

Example 2: Based on a 2.000m x 2.000m grid, calculate the inside area of the octagonal shape.



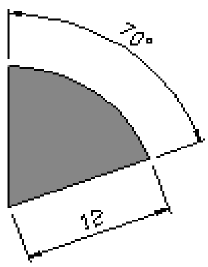
Area of one square	=	L x W
	=	2 x 2
	=	**4.0m^2**
Area of one triangle	=	0.5 x b x h
	=	(0.5 x 2) x 2
	=	**2.0m^2**
Total area	=	5 x squares + 4 x triangles
	=	(5 x 4) + (4 x 2)
	=	20 + 8
	=	**28.0m^2**

Area of a sector

A sector is part of a circle. The key to calculating the area of a sector is to consider it as a fraction (or portion) of a whole circle. It is calculated by multiplying the fraction of the circle (that the sector represents) by the area of the whole circle.

The fraction of the circle is the degree of angle of the sector divided by 360. This is represented as N÷360, where N is the angle (in degrees) of the sector.

Example: Calculate the area of the sector shown.



Formula for area of sector $= \frac{N}{360} \times \pi r^2$

Area of sector $= \frac{70}{360} \times \pi \times 12 \times 12$

Answer = **87·97 sq metres**

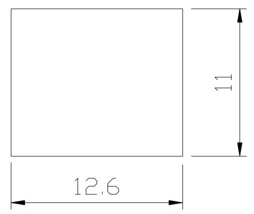
Activity 4

Calculate the area of each of the following shapes. These shapes are commonly found on building, construction and manufacturing sites and form the basis of most quantity and costing exercises. All dimensions are in metres.

1. Calculate the area.

Formula:

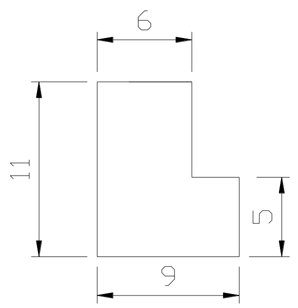
Answer:



2. Calculate the area.

Formula:

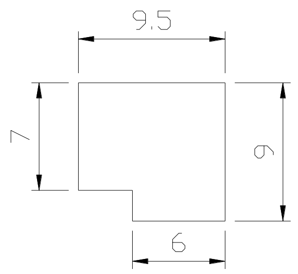
Answer:



3. Calculate the perimeter and the area.

Formula: perimeter

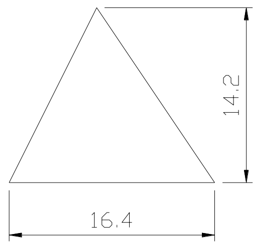
Answer: perimeter



Formula: area:

Answer: area:

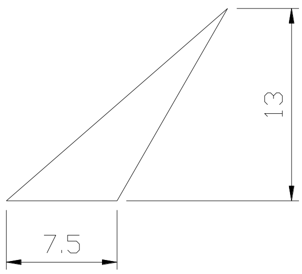
4. Calculate the area



Formula: area:

Answer: area:

5. Calculate the area

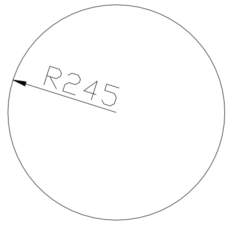


Formula: area

Answer: area

6. Calculate the areas of the following circles

Circle with a radius of 245 mm

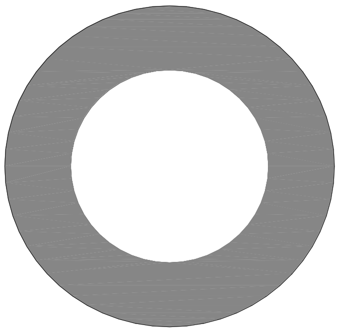


Circle with a diameter of 25 metres

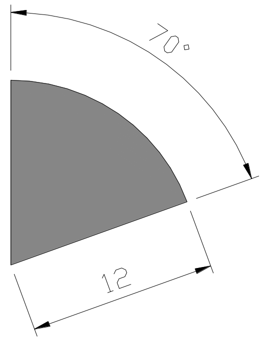
Circle with a radius of 12 metres

7. Calculate the shaded area

External diameter 2.5 metres and internal diameter 1.2 metres

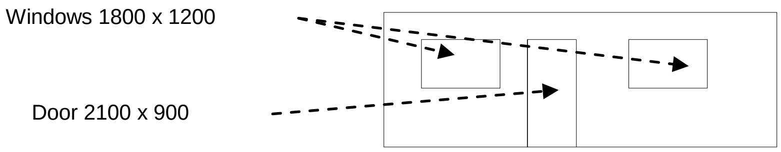


Calculate the area of the sector (dimensions are in metres)



8. A room measuring 7300 x 3800mm needs to be painted.
The room has one door measuring 2100 x 900mm and two windows each measuring 1800 x 1200mm. (Refer to diagram below.) The wall height is 2400mm.

a) Calculate how many square metres of wall area needs painting



b) Calculate the amount of paint required to apply one coat to the internal walls. One litre of paint covers approximately 16m^2.

c) The ceiling of the room is also to be painted. Calculate the total amount of paint needed to coat both the ceiling and the walls.

d) A painter can cover 7 sq. metres in an hour. Calculate how long it would take to paint the internal walls and ceiling of the room?

Volume

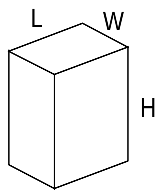
Volume is the amount of space that an object will take up. It is expressed in units cubed (e.g. metres^3 or m^3).

Volume of a prism

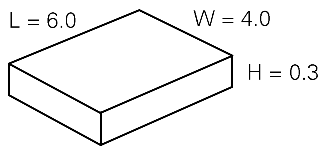
The volume of a prism can be found in two different ways:

1. By multiplying the length of the prism by the width of the prism by the height of the prism.
(Length x Width x Height or L x W x H)

2. By working out the area of one of the prism's faces and multiplying it by the height of the prism.
(Area x Height)



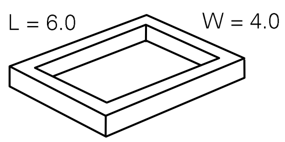
Example 1: Calculate the amount of hardfill at a depth of 300mm underneath a floor slab 6.0m x 4.0m.



Volume of hardfill = Length x Width x Height
= 6.0 x 4.0 x 0.3
7.2m^3

Example 2: Calculate the amount of concrete required for a foundation footing for a floor slab that is 6.0m long by 4.0m wide. The foundation footing is 0.350m deep by 0.450m wide.

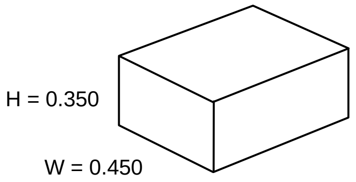
1. Calculate the footing perimeter.



Perimeter of footing = 2 x (Length + Width)
= 2 x (6 + 4)
= 2 x 10
= **20m**

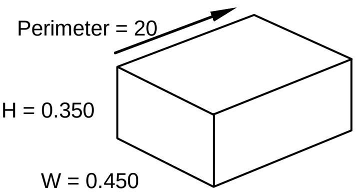
Example 2 continued:

2. Calculate the cross-sectional area of the footing.



Area of footing	=	Width x Height
	=	0.450 x 0.350
		0.1575m^2

3. Calculate the volume of the footing.



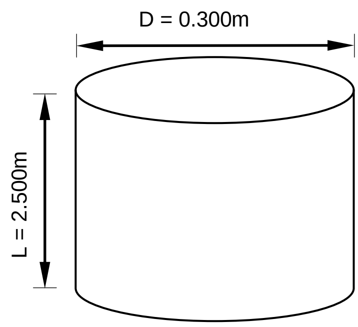
Volume of footing	=	Area x Perimeter
	=	0.1575 x 20
		3.15m^3

Volume of a cylinder

The volume of a cylinder is found by using the following formula:

Volume = $\pi r^2 \times L$

Example: Calculate the amount of concrete required for a column 0.300m in diameter and 2.500m length.



Volume	=	πr^2 x Length (L)
	=	(3.142 x 0.150^2) x 2.5
	=	(3.142 x 0.0225) x 2.5
	=	0.070695 x 2.5
	=	**0.177m^3**

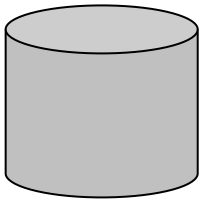
Another way of approaching the concept of volume is to consider that it is the cross-section area x length (or height, depending on its application).

Volume is extensively used within industry to calculate the size or weight of a given object as well as being used to calculate the amount of materials that are needed to complete a job, e.g. the amount of concrete to be ordered.

Activity 5

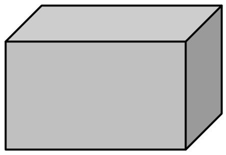
1. Cross-section area = $80m^2$ Height = 3m

Calculate the volume:



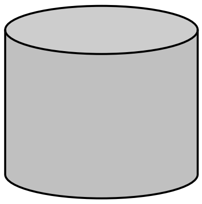
2. Cross-section area = $40m^2$ Length = 3.5m

Calculate the volume:



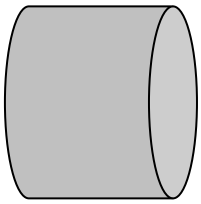
9. Cross-section area = $2500mm^2$ Height = 350mm

Calculate the volume:



10. Cross-section area = $3400mm^2$ Length = 285mm

Calculate the volume:



Cones and pyramids

The volume of a pyramid or cone can be calculated using the following formula

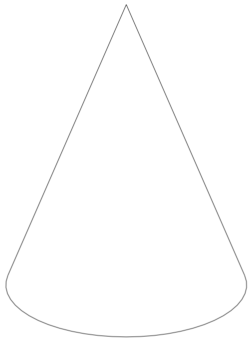
Volume = 1/3 area of base x height
The formula for a circular base = πr^2 x 1/3 h

Activity 6

1. Calculate the volume: diameter of base = 2 metres, height = 3.3 metres

Formula:

Volume:

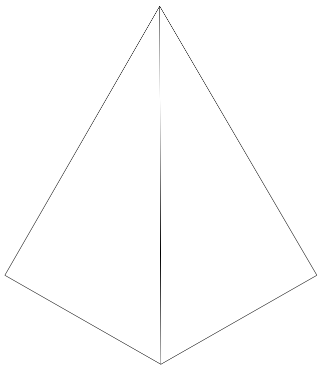


2. The formula for a square base = l x w x 1/3 h

Calculate the volume: base = 2.5 x 2.5 metres; height = 3.5 metres.

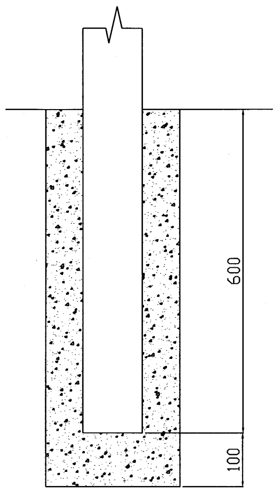
Formula:

Volume:



3. A post needs to be concreted into a hole.

- The hole has a diameter of 300mm and a depth of 700mm.
- The post is 125mm x 125mm and is positioned with 100mm of concrete under the post.



Calculate the m^2 of concrete that is required to fill the hole.

4. A fence needs 25 posts to be concreted into holes.

- The holes have a diameter of 250mm and a depth of 700mm.
- The posts are 100mm x 50mm and are positioned with 100mm of concrete under each post.

Calculate the volume of concrete in cubic metres that is needed to concrete the posts in the holes.

Volume and capacity

Volume can be used to calculate the storage capacity of containers.

- $1m^3$ = 1000 litres of liquid
- $1m^3$ = 1m x 1m x 1m
- or 1000mm x 1000mm x 1000mm

Activity 7

1. A swimming pool measures 30 metres long x 8 metres wide. The deep end is 1.6 metres and the shallow end is 1.2 metres. How much water is needed to fill the pool? Produce a sketch in the space provided.

2. A rectangular fuel tank is fitted in a boat. Its dimensions are 1200mm long x 300mm wide x 200mm deep. How many litres of fuel will it contain?

3. A rainwater storage drum has a diameter of 3.2 metres and a height of 3 metres. How much water will it hold when it is ¾ full?

4. A work trailer is 2.4 metres long x 1.2 wide with 300mm sides. Calculate the volume of builder's mix that the trailer could carry if it was loaded level with the top of the sides.

5. How many trailer loads would it take to transport 2.5 cubic metres of builder's mix to the job?

Calculating Mass (weight)

Volume can be used to assist with the calculation of the weight of an object. Multiply the volume by the density to find the mass of a material.

Volume x Density = Mass

Activity 8

1. Concrete has a density of 2305kg/m^3. Calculate the weight of a slab that is 3.5m x 2.5m x .01m thick.

2. Builder's mix has a density of 2000kg/m^3. Calculate the weight of a trailer load of builder's mix 2.4m long x 1.2m wide x 0.3m high.

3. Fresh water has a density of 1000kg/m^3. A stand needs to be built to support a fish tank. The structure needs to be strong enough to support the tank's weight. The tank is 900mm long x 400mm wide x 500mm high. Calculate the weight of the tank.

The structure will support 150 kilograms. Is it strong enough to support a full fish tank?

Answer =

Trigonometry

Trigonometry, which means literally *the measurement of triangles*, is the branch of mathematics that deals with the relationship and calculation of the unknown sides and angles of a triangle.

Applications of trigonometry can be found extensively in the construction and manufacturing sectors, with the most common relating to calculations involved in the setting out of buildings and roofing calculations. It is also useful in navigation, surveying and other disciplines where distances have to be calculated from the measurement of angles.

It is important that students and trainees understand and become familiar with the use of basic trigonometry operations.

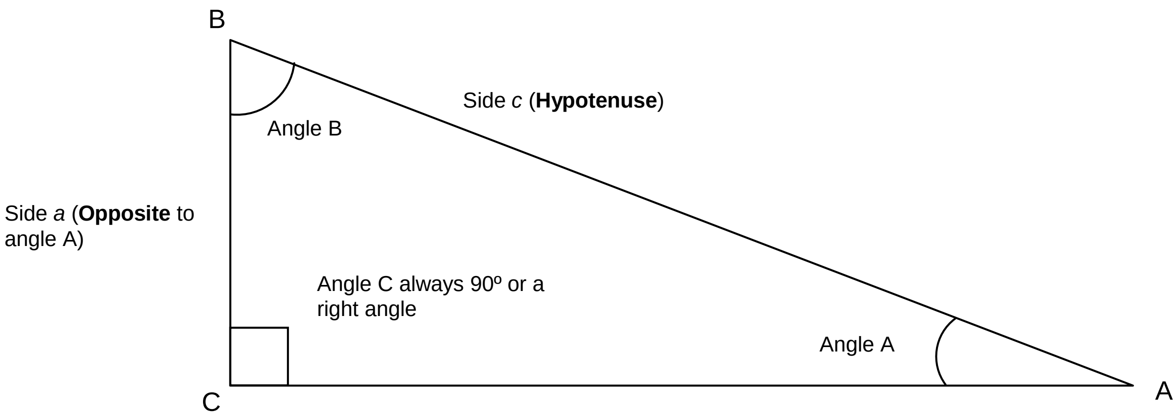
Mathematical principles

There are three main mathematical principles, which need to be fully understood

- the triangle theorem;
- the Pythagoras theorem; and
- the sine, cosine and tangent rules.

Each of these principles has an important role in the calculation of the unknown measurement.

Right-angled triangle trigonometry



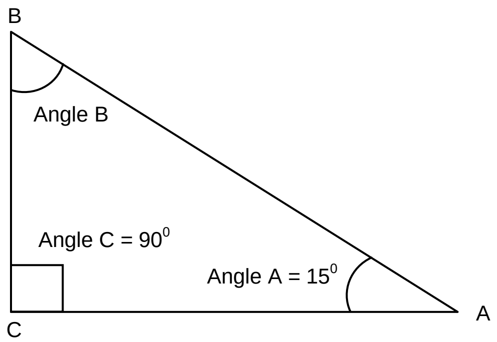
Note: *The side is labelled according to the angle it is opposite.*

Triangle theorem

The sum of the three internal angles of a triangle is 180º i.e. the internal angles of a triangle will always add up to180º.

Angle A + Angle B + Angle C = 180º.

Example: Find Angle B, where Angle A is 15º and Angle C is 90º.

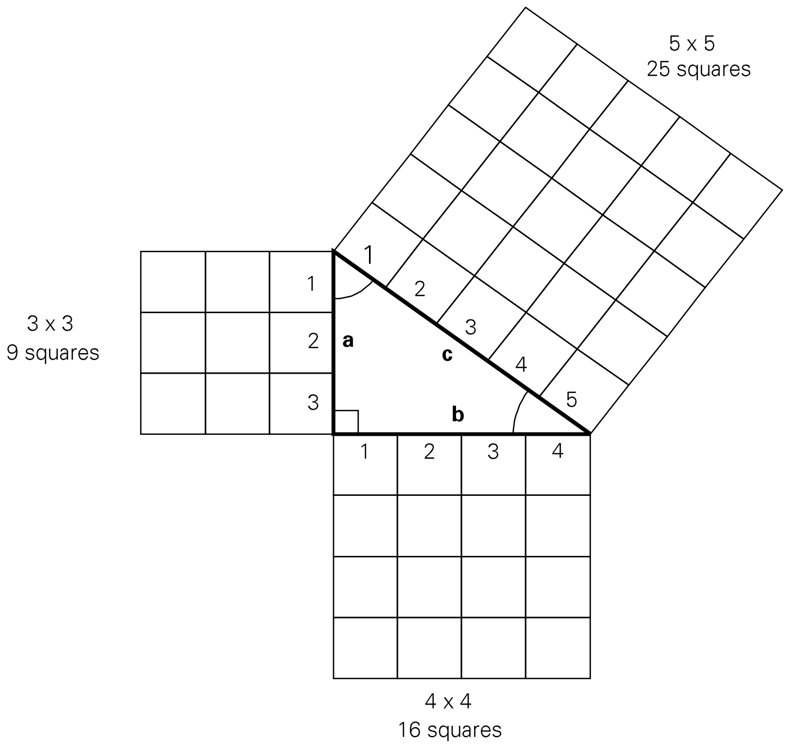


The sum of angles	=	A + B + C
	=	15º + Angle B + 90º
	=	180º
Angle B	=	180º – (A + C)
	=	180º – (15º + 90º)
	=	180º – 105º
Angle B	=	**75º**

Pythagoras' theorem

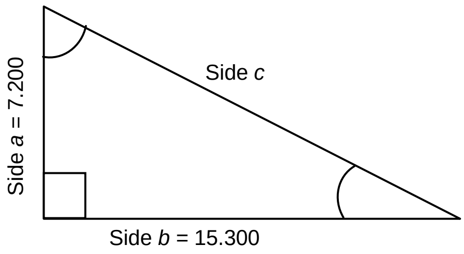
The Pythagoras theorem states that the square on the hypotenuse of a right-angled triangle is equal in area to the sum of the squares on the other two sides.

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



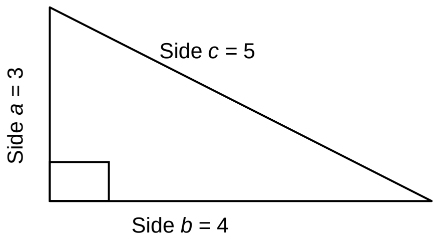
Using the Pythagoras theorem to find the length of an unknown side of a triangle

Example: The lengths of two sides of a triangle are given as Side a = 7.200m and Side b = 15.300m. (Use a calculator to perform each step in the following example.) Calculate the length of Side c.



c^2	=	$a^2 + b^2$
	=	$7.200^2 + 15.300^2$
	=	$51.84 + 234.09$
	=	285.93
c (take the square root of both sides)	=	$\sqrt{285.93}$
c	=	**16.909**

The simplest application of the Pythagoras theorem on a construction site is the 3, 4, 5 method, used in setting out.



c^2	=	$a^2 + b^2$
	=	$3^2 + 4^2$
	=	$9 + 16$
	=	25
c (take the square root of both sides)	=	$\sqrt{25}$
c	=	**5**

Some common triangles

A triangle with the ratios of 3:4:5 will always provide a right angled triangle. This ratio is often used in construction to test structures for square and to assist with the laying out of site works.

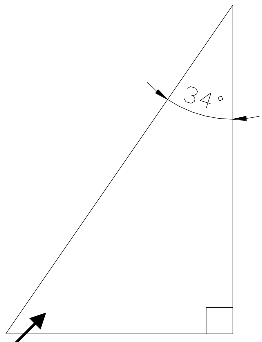
This method can be used for any multiples of 3, 4, 5:
e.g. multiply by 2 gives 6, 8, 10
multiply by 5 gives 15, 20, 25.

Activity 9

1. Calculate the degrees of the internal angles for the following triangles (show all calculations)

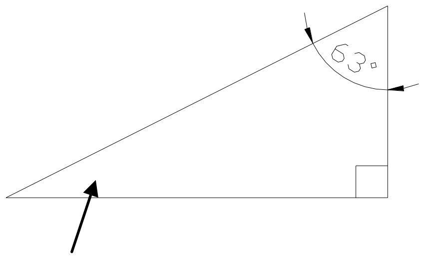
Note: The sum of the internal angles of a triangle is 180º.

Calculate angle x:



Angle x

Calculate angle y:



Angle y

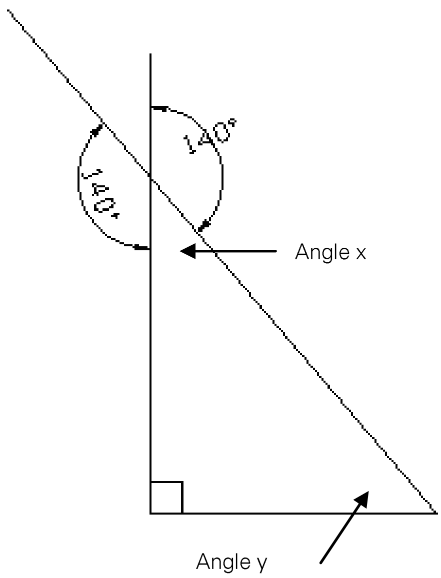
The sum of angles based along a straight line is 180 degrees.

The sum of angles based around a circle is 360 degrees.

2. Calculate all of the internal angles for the following problems.

Angle x:

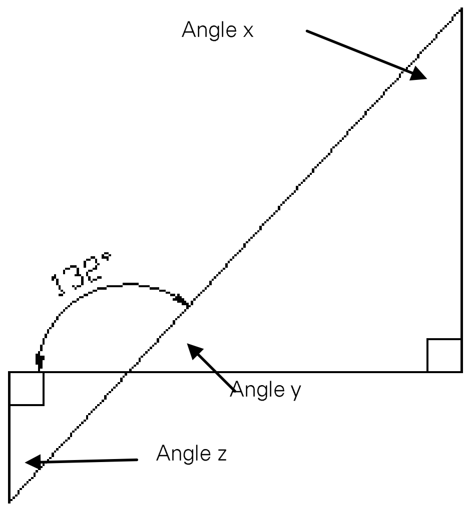
Angle y:



Angle x:

Angle y:

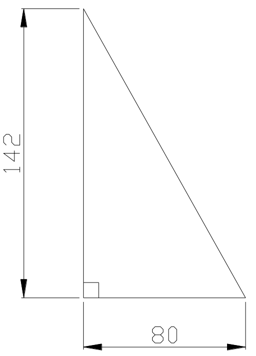
Angle z:



3. Use the Pythagoras theorem to calculate the lengths of the triangle sides.

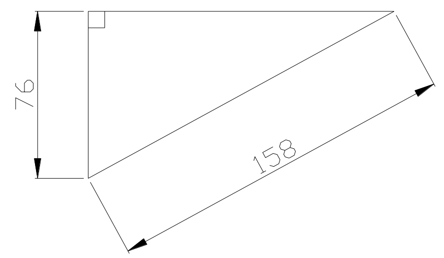
Formula:

Answer:



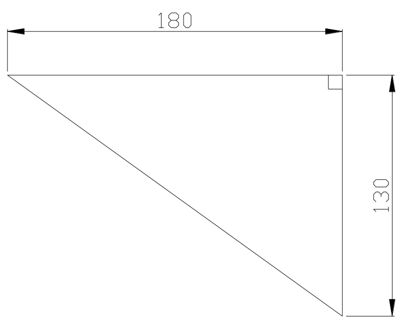
Formula:

Answer:



Formula:

Answer:



Assessment Schedule

US 24361 Apply mathematical processes to BCATS projects (Level 2, Credit 3)

Outcome 1	Establish outcome requirements and select mathematical methods for solving problems for BCATS projects.	**Assessment evidence and judgement**
ER 1.1	Outcome requirements of the situation are identified.	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where outcome requirements of a project are identified • or a combination of worksheet scenarios and practical projects
ER 1.2	Method chosen is in accordance with the situation and the problem. Range: a combination of two of the following – numerical calculation, measurement, geometry, trigonometry.	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where chosen mathematical methods include a combination of two of the following - numerical calculation, measurement, geometry, trigonometry • or a combination of worksheet scenarios and practical projects
Outcome 2	Use mathematical skills to solve problems for BCATS projects. Range: trigonometry and at least one of the following – numerical calculation, measurement, geometry.	**Assessment evidence and judgement**
ER 2.1	Chosen methods applied in the context of the situation provided.	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where the correct mathematical skill has been applied to solve problems including trigonometry and at least one of – numerical calculation, measurement, geometry • or a combination of worksheet scenarios and practical projects
ER 2.2	Mathematical skills are linked to solve problems.	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where the correct mathematical skill has been linked to solve problems including trigonometry and at least one of – numerical calculation, measurement, geometry • or a combination of worksheet scenarios and practical projects
ER 2.3	Solutions accurate, and consistent with the outcome requirements of the problems.	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where the mathematical solutions are accurate and consistent with the required outcomes including trigonometry and at least one of – numerical calculation, measurement, geometry • or a combination of worksheet scenarios and practical projects.
ER 2.4	Information and results are accurately presented. Range: includes cutting lists, job sheets, diagrams	Evidence must be for 2 different situations using; • Completed and correct worksheet or • Detailed evidence of practical projects where information and results are accurately presented including trigonometry and at least one of – numerical calculation, measurement, geometry • or a combination of worksheet scenarios and practical projects