CARRY OUT MEASUREMENTS AND CALCULATIONS
CERTIFICATE II IN BUILDING AND CONSTRUCTION
(PATHWAY – TRADES)
CPCCCM1015A
LEARNER’S GUIDE
BUILDING AND CONSTRUCTION

BC2120
Carry out measurements and calculations

CPCCCM1015A

Learner’s guide
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Annex A – Unit details

Annex B – Assessments

Annex C – Plans
Welcome

This learner’s guide will provide you with an introduction to carrying out measurements and calculations.

Areas of explanation include:

• taking measurements from plans
• taking physical measurements
• performing calculations
• calculating and estimating material quantities.

Qualification overview

This unit of competency, CPCCCM1015A *Carry out measurements and calculations*, forms part of Certificate II in Building and Construction (Pathway – Trades), a pre-vocational course for learners seeking to gain an apprenticeship in the building and construction industry. The focus of this course is on developing relevant technical, vocational and interpersonal competencies as well as skills, knowledge and experiences that may be transferable to other industry areas. You will also gain employability skills relevant to an entry level employee of the industry.

The first component of the course consists of seven core units of competency (common to 11 construction trades) and a period of work placement. This component, which would typically be delivered over a one-year period, is designed to provide you with a tradesperson’s introduction to the building and construction industry.

In the second component of the course, typically undertaken in the second year of study, you will choose from 10 trade-specific streams of units of competency that enable you to focus your learning on a particular trade such as bricklaying, painting or carpentry.

To progress further in the industry, beyond this introductory level, you will then need to gain an apprenticeship in your chosen trades area, or pursue further training within the building and construction field.

**Note:** If you are completing this unit as part of a different qualification, your lecturer will give you the relevant information.
Unit overview

This unit describes the performance outcomes, skills and knowledge required to carry out measurements and calculations.

Competence in this unit will be demonstrated by successful completion of three open-book assessments requiring you to:

- carry out calculations using a calculator
- apply formulas and units
- calculate perimeter, area and volume
- calculate and estimate material quantities.

Some basic information about this unit of competency is provided here. You can find the full unit details at Annex A at the back of this guide.

<table>
<thead>
<tr>
<th>Unit title</th>
<th>Carry out measurements and calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptor</strong></td>
<td>This unit of competency specifies the outcomes required to carry out measurements and perform simple calculations to determine task and material requirements for a job in a construction work environment.</td>
</tr>
<tr>
<td><strong>Employability skills</strong></td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td><strong>Prerequisite units</strong></td>
<td>Nil</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>This unit of competency supports achievement of skills to take measurements and use these to calculate material qualities and calculations for related tasks commonly used and applied in construction work.</td>
</tr>
</tbody>
</table>
**Element 1 Plan and prepare**

1.1 Work instructions are confirmed and applied using relevant *information*.

1.2 *Safety (OHS)* requirements are obtained from site safety plan, other regulatory specifications or legal obligations, and are applied.

1.3 Measuring and calculating *equipment* selected to carry out tasks is consistent with job requirements, is checked for serviceability, and any faults are rectified or reported.

**Element 2 Obtain measurements**

2.1 Method of obtaining the measurement is selected and applied.

2.2 *Measurements* are obtained using a rule or tape accurate to 1 mm.

2.3 Measurements, including *areas and volumes*, are confirmed and recorded.

**Element 3 Perform calculations**

3.1 Appropriate *calculation factors* are determined and correct method is selected for achieving required result.

3.2 *Material quantities* for the project are correctly calculated using appropriate factors.

3.3 Results are confirmed and recorded.

**Element 4 Estimate approximate quantities**

4.1 Calculations for determining material requirements are taken.

4.2 Appropriate formulas for calculating quantities are selected.

4.3 Quantities are estimated from the calculations taken.

4.4 Material quantities for the project are calculated, confirmed and recorded within enterprise tolerances.
Skills recognition and recognition of prior learning (RPL)

You are encouraged to discuss with your lecturer any previous courses or work experience in which you have participated so that it can be recognised. Evidence must be provided.

Resources

Required

Your lecturer will provide you with:

- construction drawings
- measuring tapes.

You will need to provide:

- a USB thumb drive
- an A4 notepad
- an A4 file for notes, handouts and other printed documents
- a scale rule
- a basic calculator
- pens, pencils, eraser and highlighters.

Recommended

Some of these resources may be useful or of interest. Your lecturer will provide access to them if they are required.

<table>
<thead>
<tr>
<th>Information area</th>
<th>Resource</th>
<th>Publisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>All residential buildings covered by regulations</td>
<td>National Construction Code Series 2012, Building Code of Australia: Class 1 and Class 10 Buildings</td>
<td>Australian Building Codes Board</td>
</tr>
<tr>
<td>Australian Standards®</td>
<td>Varies with topic</td>
<td>SAI Global</td>
</tr>
</tbody>
</table>
Legislation

The following is a list of legislation relevant to the residential construction industry in your state or territory. These documents may be referred to during the course.

- Building Act
- Building Regulations
- Health Regulations
- Occupational Health and Safety Act and Regulations
- Safe Design of Buildings and Structures (Code of Practice)
- Residential Design Codes

Useful websites

The following is a list of websites that contain further information relevant to the construction and residential building industries.

- Australian Building Codes Board (ABCB) <www.abcb.gov.au>
- Building Designers Association of Australia (BDAA) <www.bdaa.com.au>
- Housing Industry Association (HIA) <www.hia.com.au>
- Master Builders Australia (MBA) <www.masterbuilders.com.au>
- SAI Global <www.saiglobal.com>

Common abbreviations

Throughout this guide you’ll come across some abbreviations. Below is a list of the most commonly used ones.

AHD  Australian Height Datum
BM   Benchmark
RL   Relative level
Self-checklist

As you work through this guide you are advised to return to this checklist and record your progress. Where you understand something and think that you can perform it ‘easily’, congratulations. Where your response is ‘with help’ – review the material in that section and/or discuss it with your lecturer or other learners in your group.

<table>
<thead>
<tr>
<th>CPCCCM1015A Carry out measurements and calculations</th>
<th>I understand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element 1 Plan and prepare</strong></td>
<td>Easily</td>
</tr>
<tr>
<td>1.1 Work instructions are confirmed and applied using relevant <strong>information</strong>.</td>
<td></td>
</tr>
<tr>
<td>1.2 <strong>Safety (OHS)</strong> requirements are obtained from site safety plan, other regulatory specifications or legal obligations, and are applied.</td>
<td></td>
</tr>
<tr>
<td>1.3 Measuring and calculating <strong>equipment</strong> selected to carry out tasks is consistent with job requirements, is checked for serviceability, and any faults are rectified or reported.</td>
<td></td>
</tr>
<tr>
<td><strong>Element 2 Obtain measurements</strong></td>
<td>Easily</td>
</tr>
<tr>
<td>2.1 Method of obtaining the measurement is selected and applied.</td>
<td></td>
</tr>
<tr>
<td>2.2 <strong>Measurements</strong> are obtained using a rule or tape accurate to 1 mm.</td>
<td></td>
</tr>
<tr>
<td>2.3 Measurements, including <strong>areas and volumes</strong>, are confirmed and recorded.</td>
<td></td>
</tr>
<tr>
<td><strong>Element 3 Perform calculations</strong></td>
<td>Easily</td>
</tr>
<tr>
<td>3.1 Appropriate <strong>calculation factors</strong> are determined and correct method is selected for achieving required result.</td>
<td></td>
</tr>
<tr>
<td>3.2 <strong>Material quantities</strong> for the project are correctly calculated using appropriate factors.</td>
<td></td>
</tr>
<tr>
<td>3.3 Results are confirmed and recorded.</td>
<td></td>
</tr>
<tr>
<td>Element 4 Estimate approximate quantities</td>
<td>Easily</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>4.1. Calculations for determining material requirements are taken.</td>
<td></td>
</tr>
<tr>
<td>4.2. Appropriate formulas for calculating quantities are selected.</td>
<td></td>
</tr>
<tr>
<td>4.3. Quantities are estimated from the calculations taken.</td>
<td></td>
</tr>
<tr>
<td>4.4. Material quantities for the project are calculated, confirmed and recorded within enterprise tolerances.</td>
<td></td>
</tr>
</tbody>
</table>
About the icons

Note that not all icons may appear in this guide.

**Performance criteria**
This icon indicates the performance criteria covered in a section. The performance criteria contribute to the elements of competency that you must demonstrate in your assessment.

**Activity**
This icon indicates that there is an activity for you to do.

**Group activity**
This icon indicates that there is an activity for you to do with a partner or in a group.

**Discussion**
This icon indicates that there will be a discussion, which could be with a partner, a group or the whole class.

**Research**
This icon indicates that you are to do a research activity using the internet, texts, journals or other relevant sources to find out about something.

**Case study**
This icon indicates that there is a case study or scenario to read.

**Think**
This icon indicates that you should stop and think for a moment about the point being made or the question being asked.

You will also see the following characters used throughout this guide, where there’s a case study or activity that’s specific to a particular trade.

- Dave
  - A bricklayer

- Emma
  - A painter

- Liam
  - A tiler

- Katherine
  - A carpenter

- Jim
  - A supervisor

- Christine
  - An apprentice

- Jeremy
  - An apprentice
Section 1 – Work instructions

Introduction

In the building industry, most of the information required by the people performing any of the work related to a construction project comes from project documentation. So it's extremely important for you to be able to read and interpret plans, drawings, details and specifications correctly.

Plans and drawings are used to communicate great amounts of technical information between the designer and builder. This technical information must be able to be communicated without any misunderstandings, which can only happen if the technical language of plans and drawings is understood by everyone who uses them.

The technical language for plans and drawings uses standardised layouts, symbols and abbreviations, so that things look similar in any plan or drawing. With study, practice and experience, you'll get to know and understand this language and be able to follow work instructions.

Performance criterion

1.1 Work instructions are confirmed and applied using relevant information.
Types of information

Before you begin a work task, it's important that you review and understand relevant information so that you can apply correct processes to the planning and preparation of a work activity.

Such information can come in either written or verbal form. Here are a few examples of the types of information you may need to plan and prepare for a task involving measurements and calculations.

**Verbal information**

Instructions received verbally from:
- clients
- workmates
- employers
- supervisors, builders, contractors and subcontractors
- architects.

**Written information**

Written instructions such as:
- plans, drawings and specifications
- manufacturers’ instructions and specifications on plant, tools, equipment and materials
- maps on job location
- safety data sheets (SDSs)
- job safety analyses (JSAs)
- legislative requirements:
  - WHS/OHS Act
  - Regulations
- Australian Standards® on work practices and processes
- safe working procedures:
  - manual handling
  - noise
  - chemicals
- signs.
Types of plans and drawings

There are many types of plans and drawings that may be created for a building project. The size and complexity of the project will determine which ones are required. The minimum set usually includes:

• a site plan
• a floor plan
• elevations
• sections.

Others that may be required, depending on the project, include:

• details
• electrical plans
• hydraulic plans
• engineering plans.

Users and uses

When plans and drawings of a proposed building or structure have been prepared, many copies are made for the people who will use them. The table on the next page shows who might use them and for what purpose.
<table>
<thead>
<tr>
<th>User</th>
<th>Use plans to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner/client</td>
<td>see that the design is as they imagined it</td>
</tr>
<tr>
<td>Structural, electrical and mechanical engineers</td>
<td>design their part of the structure</td>
</tr>
<tr>
<td>Council health and building surveyors</td>
<td>make sure that the building conforms to building codes and council regulations</td>
</tr>
<tr>
<td>Council town planning officers</td>
<td>make sure that the building conforms to council planning regulations</td>
</tr>
<tr>
<td>Financial institution officers</td>
<td>decide whether approval for finance for construction will be given</td>
</tr>
<tr>
<td>Builder/estimator</td>
<td>cost the building and to prepare a quote</td>
</tr>
<tr>
<td>Builder</td>
<td>construct the building</td>
</tr>
<tr>
<td>Subcontractors such as concreters, bricklayers,</td>
<td>prepare their quotes to carry out their part of the construction</td>
</tr>
<tr>
<td>electricians, tilers and painters</td>
<td></td>
</tr>
<tr>
<td>Suppliers of prefabricated building components</td>
<td>calculate their prices for their part of the job.</td>
</tr>
<tr>
<td>such as roof trusses, windows, air conditioning</td>
<td></td>
</tr>
<tr>
<td>and heating</td>
<td></td>
</tr>
</tbody>
</table>
Finding information

The unit CPCCCM2001A *Read and interpret plans and specifications* goes into much more detail about the information found on plans and drawings and how to interpret it. You should already have completed this unit or be enrolled in it now. Try Activity 1.1 to check your knowledge about finding information on plans and drawings.

**Activity 1.1 Information on plans and drawings**

In the table below, four types of plans or drawings are listed across the top and 11 items of information that can be found on them are listed down the left-hand side.

For each piece of information, decide which plan or drawing it's shown on and place a tick in the corresponding box. Some information appears on more than one plan or drawing, so you may need two ticks for those. The first one has been done for you as an example.

<table>
<thead>
<tr>
<th></th>
<th>Site plan</th>
<th>Floor plan</th>
<th>Elevation</th>
<th>Electrical plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of paths</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall width of building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of windows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of ceiling fans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of sink cupboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of windows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitch (slope) of roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of front door</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of WC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of light switches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Measurements**

Plans and drawings show things that are to be constructed, such as foundations, walls and fences. They also show what’s already on or near the site, such as trees, services and neighbouring buildings.

As well as these tangible items (things we can actually see or touch), plans and drawings also show lots of other important information, including levels, gradients, heights and measurements.

**Levels**

Levels are a very important part of construction. When the first drawings are done for a project, a ‘datum’ is established. The datum is a point that is chosen by the surveyor, assigned a number in metres and then used as the baseline or starting point for all the height measurements, or levels, on the project.

The surveyor chooses a point close to the site to locate the datum, often in the road or on the kerb, and marks it using a nail or a small metal plate. The surveyor then marks the datum on the site plan and gives it a number value, usually 10.00 or 100.00. The number itself doesn’t mean anything; it just provides a point for all other heights or levels on site to be measured against.

For example, if the datum is given the value of 10.00, then a point that is 1000 mm, or one metre, higher than the datum would be given a level of 11.00 on the site plan. A point that is 2500 mm higher than the datum would be given a level of 12.50, as shown here.

Section through ground showing relative levels (RLs) at three points.
The datum can, if necessary, be related to the nearest public datum or permanent benchmark, such as the Australian Height Datum (AHD). The AHD is a geodetic datum for altitude measurement in Australia. It allows the heights of places or points that are not within sight of each other to be compared.

Can you think of an example of a project that might need to use the Australian Height Datum?

**Level line**

A level line is a line that is at a constant height relative to mean sea level (it is therefore a curved line because the earth is curved).

**Level datum**

A level datum is a reference level to which the elevation of other points may be referred. In Australia, the AHD is the commonly adopted reference level. A level datum may also be assigned an arbitrary value.

**Benchmark**

A benchmark (BM) is a fixed point of reference that has a known elevation above (or below) a particular datum.
Gradient

The gradient (also called slope, incline, pitch or rise) of a physical feature refers to the amount of inclination of that surface to the horizontal. It's used in measuring existing physical features (such as hillsides and riverbanks), and in designing and engineering new elements for construction (such as roads, landscaping and roofing).

Contour lines

These are imaginary level lines that indicate the shape of the land (you might have seen these on maps).

Everything that is done on a construction project relies on accurate heights and levels being used. A lot of this information is found on the site plan.

Activity 1.2 Finding information on a site plan

Find the following items on the Hopscotch Homes plan on the following page. Write the required information next to each one.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The address of the site</td>
</tr>
<tr>
<td>2.</td>
<td>The height of the four corner pegs</td>
</tr>
<tr>
<td>3.</td>
<td>The datum level</td>
</tr>
<tr>
<td>4.</td>
<td>The location of the meter box</td>
</tr>
<tr>
<td>5.</td>
<td>The length of the northern boundary</td>
</tr>
</tbody>
</table>
Which units are used?

The metric system is used in Australia. Some other countries use the imperial system (measuring length in feet and inches, for example). Always use the metric system when reading, measuring or calculating quantities for building projects in Australia.

The most commonly used unit of measurement in the construction industry is millimetres (mm). Lengths, widths, depths and heights are usually given in millimetres. Where larger dimensions are shown, such as the length of boundaries on a site plan, metres (m) will be used. Centimetres are very rarely used.

Often the unit itself is not written. For example, everyone just knows that if 3600 is written it means millimetres, whereas if 3.600 is written it means metres.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
<th>Example</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millimetre</td>
<td>mm</td>
<td>A fence could be 1200 high.</td>
<td>1 mm = 0.001 m</td>
</tr>
<tr>
<td>Centimetre</td>
<td>cm</td>
<td>Rarely used in the construction industry.</td>
<td>1 cm = 10 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 cm = 1 m</td>
</tr>
<tr>
<td>Metre</td>
<td>m</td>
<td>A fence could be 14.60 long.</td>
<td>1 m = 1000 mm</td>
</tr>
</tbody>
</table>

Converting metres and millimetres

Sometimes it's necessary to convert metres to millimetres. One metre is 1000 times longer than one millimetre, so you just need to remove the decimal point and make sure there are three figures after the metre amount.

For example:

- 2.657 m becomes 2657 mm
- 4.32 m becomes 4320 mm.

To convert millimetres to metres, move the decimal point three places to the left to make the number read as one thousand times smaller.

For example:

- 2460 mm becomes 2.46 m
- 12795 mm becomes 12.795 m.
If the number of millimetres is less than 1000, put a zero before the decimal point.

For example:

795 mm becomes 0.795 m.

If the number of millimetres is less than three figures, add zeroes to the left end and then place the decimal point.

For example:

65 mm becomes 0.065 m  
8 mm becomes 0.008 m.

### Activity 1.3 Conversions

**Convert the following measurements to millimetres. An example has been done for you.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.756 metres</td>
<td>756 mm</td>
</tr>
<tr>
<td>1.46 m</td>
<td></td>
</tr>
<tr>
<td>21.05 m</td>
<td></td>
</tr>
<tr>
<td>14.749 metres</td>
<td></td>
</tr>
<tr>
<td>5.008 m</td>
<td></td>
</tr>
</tbody>
</table>

**Convert the following measurements to metres. An example has been done for you.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>649 millimetres</td>
<td>0.649 m</td>
</tr>
<tr>
<td>1840 millimetres</td>
<td></td>
</tr>
<tr>
<td>4550 mm</td>
<td></td>
</tr>
<tr>
<td>12001 mm</td>
<td></td>
</tr>
<tr>
<td>124 mm</td>
<td></td>
</tr>
</tbody>
</table>

You will have more opportunities to practise conversions later in this unit.
Activity 1.4 Interpreting a site plan

These questions relate to the site plan on the following page. Study the plan, and then choose the correct answer for each of the nine multiple-choice questions below.

1. The width of the building (excluding the garage) is:
   a) 11.79
   b) 17.49
   c) 13.55
   d) 13.612.

2. The wavy line that runs across the block (with 28.5 written at one end) is:
   a) a contour line
   b) the main sewer line
   c) indicating the position of an old road
   d) indicating an existing watercourse (stream).

3. The ‘FFL’ under ‘Proposed Residence’ is:
   a) flush floor level
   b) 28.6 m
   c) 28.60 AHD
   d) 28.50 AHD.

4. The front elevation of the house faces:
   a) west
   b) south west
   c) east
   d) south east.

5. The setback of the house from the front boundary is:
   a) 6.795 mm
   b) 1.00 mm
   c) 6.00 m
   d) 2.80 m.

6. The address of the site is:
   a) Lot 259 Caladenia Way
   b) Hopscotch Homes
   c) Lot 92 Bitter Way Beechboro
   d) not shown.

7. The distance from the rear of the house to the back boundary is:
   a) 29.21 m
   b) not shown
   c) 5.255 m
   d) 6.968 m.

8. The distance from the side of the house to the southern boundary is:
   a) 1.50 m
   b) 1.00 m
   c) 1500 m
   d) not shown.

9. The existing ground level of the block is:
   a) dead level
   b) sloped down towards the top right-hand corner
   c) unable to be determined
   d) sloped down from the rear of the block to the front.
HIA plans have been reproduced with the permission of Housing Industry Association Ltd.
Carry out measurements and calculations

CPCCM1015A
Section 2 – Working safely

Introduction

Work health and safety is everyone’s responsibility. Working safely is covered thoroughly in the unit CPCCOHS2001A Apply OHS requirements, policies and procedures in the construction industry, but a brief overview is included here.

Performance criteria

1.1 Work instructions are confirmed and applied using relevant information.
1.2 Safety (OHS) requirements are obtained from site safety plan, other regulatory specifications or legal obligations, and are applied.

All employees must take reasonable care of their own health and safety and that of others, and cooperate with employers in their efforts to comply with work health and safety (WHS) requirements.

As an employee, you must not:

• interfere with or misuse any item provided for the health, safety or welfare of people at work
• block or interfere with attempts to give aid or attempts to prevent a serious risk to the health and safety of a person at work
• refuse a reasonable request to help in giving aid or in preventing a risk to health and safety.

Note: ‘WHS’ is a relatively new term that replaces ‘OHS’ (occupational health and safety).
WHS induction training

It is a requirement under the relevant WHS Act of each state or territory that all workers carry out WHS induction training to familiarise themselves with:

- the reasons for WHS legislation
- the rights and responsibilities of employers and employees in relation to WHS legislation
- identification of common workplace hazards
- inspection of a workplace to assess risks
- identification of quality control measures to control hazards
- purpose and use of safe work method statements (SWMSs)
- identification of essential personal protective equipment (PPE)
- identification of barricades, hoardings and signs to highlight site hazards and to protect workers.

Each WHS Act requires the principal contractor and those who are self-employed to make sure that all employees have undertaken mandatory WHS induction. If they haven’t, fines can be applied.

WHS induction cards are recognised from state to state and territory to territory. As long as the training a worker has received meets existing standards and requirements, they will be permitted to carry out work on a construction site without having to undertake another WHS induction course in that state or territory. Pictured here is a ‘white card’ issued in Western Australia.

Site induction

Workers who are going to be on site need to undertake a site induction before they enter the site. Any site-specific safety issues will be highlighted during the site induction, and you will also be taken through emergency procedures and other safety-related information relevant to the site.
Section 2 – Working safely

Activity 2.1 WHS induction training

Read each of the statements below, then decide whether they are true or false. Tick the correct box.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is not a requirement in all states and territories of Australia that WHS induction training be carried out.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
<tr>
<td>Your white card will expire every twelve months.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
<tr>
<td>As long as the training that a worker has received meets existing standards and requirements, WHS induction cards are recognised from state to state and territory to territory.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
<tr>
<td>If you don’t pass your WHS induction training, you are issued with a black card.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
<tr>
<td>If a worker has received the proper WHS induction training, they are permitted to carry out work on a construction site without having to undertake another WHS induction course in that same state or territory.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
<tr>
<td>The ‘white card’ can be different colours from state to state and territory to territory.</td>
<td>🗼️</td>
<td>🗼️</td>
</tr>
</tbody>
</table>

Codes of practice

Codes of practice are used in conjunction with the WHS/OHS Act, but they are not classified as legal documents. However, you are still required to follow them.

The basic purpose of codes of practice is to provide workers in the building industry with practical, commonsense, industry-acceptable ways of following the WHS/OHS Act and working safely.

They are published by each state’s and territory’s WHS regulating authority, and cover areas such as electrical safety, roof tiling, formworking, PPE, use of safety harnesses, construction and use of hoardings.
Activity 2.2 Working safely

List ten WHS policies and/or procedures that you would need to consider when carrying out basic measurements and calculations. What precautions can you take to keep yourself safe?

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________
Section 3 – Equipment for measuring and calculating

Introduction

Several pieces of equipment are available for measuring. Some are better suited than others to particular jobs.

Performance criterion

1.3 Measuring and calculating equipment selected to carry out tasks is consistent with job requirements, is checked for serviceability, and any faults are rectified or reported.

Calculators

A general-purpose calculator is required for calculations. It just needs to be a fairly small, inexpensive one that you can easily get the hang of to perform basic calculations. Later, in more detailed estimating, you’ll use a scientific calculator to perform more complex calculations.
Activity 3.1 Using a calculator for basic calculations

1. Carry out the following additions.
   a) \(17 + 316 + 5311\) = ______________________
   b) \(4.792 + 12.476 + 0.625\) = ______________________
   c) \(0.6223 + 5.7744 + 2.998\) = ______________________

2. Carry out the following subtractions.
   a) \(442 – 78\) = ______________________
   b) \(7.76 – 1.823\) = ______________________
   c) \(4\,969\,445 – 645.708\) = ______________________

3. Carry out the following multiplications.
   a) \(62.76 \times 35\) = ______________________
   b) \(26.017 \times 3.58\) = ______________________

4. Carry out the following divisions.
   a) \(1365 ÷ 35\) = ______________________
   b) \(996.325 ÷ 27.5\) = ______________________

5. Carry out the following compound calculations.
   a) \(27.5 – (2.5 \times 5)\) = ______________________
      = ______________________
   b) \((3.6 \times 1.5) + (1.8 \times 3.5)\) = ______________________
      = ______________________
Measuring tapes

A measuring tape is made up of a flexible metal blade housed in a metal or plastic case. The blade is coiled, usually under the control of a strong spring. Tapes are used for measuring long distances with a reasonable degree of accuracy. They offer greater convenience than using a series of measurements made with a shorter steel ruler.

Common types of measuring tapes can be from three to 10 metres long; however, longer lengths, such as 30 metres, are also available.

Retracting mechanisms

Smaller tapes normally retract (pull back) under spring tension once their locking button is released. Care should be taken when doing this, as the tape can snap back violently. To do it safely, hold the end of the tape in your hand, and guide it until it's fully coiled again.
Steel tapes

Steel tapes are used for measuring long distances. They are usually 10 or 30 metres long, but longer lengths are available.

Steel tapes are returned into their case by operating a turning mechanism. The handle can be folded away when not in use.

Steel tape rules

Steel tape rules are available in two, three, five, seven, eight and 10 metre lengths. The three and five metre tapes are the most common.

Steel tape rules have a power return spring which automatically returns the tape blade into the housing. Do not allow the tape to suddenly return, as the hook will break off. A lock is often included to hold the blade in the open position and to slow its return into the case.

Looking after measuring tapes

Measuring tapes will last for many years if you look after them properly.

- Don’t be rough with the blade or the tape housing.
- Retract the blade gently.
- Keep the blade free from grit and moisture.
- Don’t leave the measuring tape exposed for long periods to the direct rays of the sun. This can buckle the blade or degrade the housing.
Pictured below are some of the different ways measuring tapes can be used.

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Using measuring tapes

Measuring tapes in Australia are marked in metric measurements. Markings are placed at 1 mm apart, and numbers are written every 10 mm. Major units are written every 100 mm.

A steel tape rule is used for all types of measuring and setting out, within the range of its length. A tape rule has an advantage over a solid steel rule which can give errors when used to measure distances greater than its length.

A steel tape can be used in most situations, but is best suited for on-site setting out and taking measurements on the building site.

The fixed-end hook on a steel tape compensates for the thickness of the metal when taking inside or outside measurements, so it's important to place the tape correctly.

Reading a tape measure

Below are two readings from a tape measure for a door for a new home. The door is 2040 mm in length × 815 mm wide. When you convert the measurements into metres and move the decimal point three places to the left, the tape measure reads 2.04 m × 0.815 m.
To learn how to read the tape correctly, let’s look at the first measurement taken on the door (2040 mm). Notice that the first major unit is 2000 mm. The next sub-unit is 40 mm, therefore:

\[ 2000 \text{ mm} + 40 \text{ mm} = 2040 \text{ mm} \]

On the second measurement, the first major unit is 800 mm. The following sub-unit reads 10 mm. From the 10 mm to the end of the door, five minor increments are counted, giving a total reading of 815 mm.

\[ 800 \text{ mm} + 10 \text{ mm} + 5 \text{ mm} = 815 \text{ mm} \]

**Four-fold ruler**

Tradespeople in the construction industry are known to use the four-fold ruler. Markings are placed at 1 mm, and numbers are written every 10 mm.

When fully extended, the total length of the ruler can measure up to 1 metre. When the ruler is folded, each section of the ruler has a length of 250 mm. The ruler itself is usually made from either plastic or boxwood, and has stainless steel or brass fittings.

**Reading a ruler**

Below is an example of how to read a four-fold ruler using the black line as the end point. As with a tape measure, notice that from zero, the first major unit left of the black line is 30 mm, the second is 5 mm, then two increments have been counted from the five.

\[ 30 \text{ mm} + 5 \text{ mm} + 2 \text{ mm} = 37 \text{ mm} \]
### Activity 3.2 Measuring with tape rules

What lengths are steel tape rules available in?

What tape would be used to measure distances greater than 20 m?

In the picture below, the red line represents the end point on a tape measure. What is the measurement?

![Tape Measure](image)

A window’s width reads 1095 mm on a tape measure.

To calculate the total measurement, which of the following examples would be correct when reading the tape measure?

- a) $1000 + 85 + 10$
- b) $1085 + 10$
- c) $1000 + 90 + 5$

You need to measure the length of skirting tiles required to be laid in a laundry so that you can provide a quote. The skirting measures 2067 mm.

Which of the following examples would be correct when reading the tape measure?

- a) $1000 + 1000 + 65 + 2$
- b) $2000 + 60 + 5 + 2$
- c) $2000 + 60 + 7$

What four points should you remember so that your tape measure does not become damaged?

1. 
2. 
3. 
4. 
What is the measurement of this pencil in mm?

![Image of a pencil with measurement markings]

Which of the following examples would be correct when reading the rule?

a) 100 + 65 + 5
b) 100 + 70
c) 100 + 60 + 5

---

**Scale rules**

A scale rule is a plastic rule of 150 or 300 mm in length used to scale off dimensions when they’re not given on the drawing. They can be triangular or flat like a standard ruler.

They have a different scale printed along each edge. Some have a single scale per edge, and others have two scales combined on one edge. Different brands may vary in the way the scales are grouped. The most common scales you’ll see on a scale rule are 1:1, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200 and 1:500.

On the top edge of the rule below, the scales are 1:1 and 1:100, so the dimensions they show differ by a factor of 100.
Another scale rule edge is shown below. In this case, the dimensions differ by a factor of 10 (1:50 is 10 times larger than 1:500).

<table>
<thead>
<tr>
<th>1:50</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:500</td>
<td>0</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
</tbody>
</table>

To measure something to scale, put the zero mark on the left-hand edge of what you’re measuring, and read the length at the right-hand edge.

How to read scale

Reading scale is covered in CPCCCM2001A Read and interpret plans and specifications; however, we’ll look at the basics here. By using a scale rule, a measurement can be determined from the plan provided to its actual size. If a drawing or house plan is set at a scale of 1:100, that means that all items on the house plan are one hundred times larger in reality.

1:10 scale

The scale rule pictured below is marked at a scale of 1:10 and 1:100. To understand how to read a scale rule, let’s first look at a scale of 1:10, the top row of numbers on this rule.

- The 1:10 scale means that all items are ten times larger than shown on the drawing.
- Each increment on a scale of 1:10 represents 10 mm, then goes to 20 mm, 30 mm, 40 mm and so on until 100 mm is reached.
- From there, increments of 10 continue as 110, 120, 130, 140 and 150 all the way to 200 mm.
1:100 scale

- Each increment on a scale of 1:100 represents 100 mm, then goes to 200 mm, 300 mm, 400 mm and so on until 1000, or 1 m is reached.
- From there, increments of 100 continue as 1100 mm, 1200 mm, 1300 mm and so on all the way to 2000 or 2 m, as shown by the bottom row of numbers on this rule.

Activity 3.3 Reading a scale rule

Below is a section of a scale rule. Write the measurements indicated by each of the arrows. An example has been done for you.

- 70 mm and 700 mm
- and
- and
- and
- and
- and
- and
Case study – Measuring using scale

Christine is working on site, building a new home, where the drawings are all set at a scale of 1:100. Her supervisor has asked her to find the height of the front door. Using a scale rule, Christine has taken a measurement from the plan of 21 mm.

According to Christine’s measurement, what is the actual (real) height of the door? Write your answer in the space below.
Activity 3.4 Measuring shapes with a scale rule

Use the appropriate side of your scale rule to work out the dimensions indicated by arrows.
Write each answer neatly next to the dimension arrows.

**Scale 1:5**

**Scale 1:10**
### Activity 3.5 Using measuring and calculating equipment

Answer the following questions about measuring equipment.

1. What would you use to measure the following lengths?
   
   a) 12 m
   
   b) 13.2 mm
   
   c) 2105 mm

2. Explain the difference between a steel tape and a steel tape rule.

3. Add 950 mm, 67 mm and 48 mm together.

4. Add these measurements together without a calculator: 1.25 m, 2.36 m and 11.75 m. Show your working out.

5. Subtract 790 mm from 3.0 m, and give the answer in both millimetres and metres.

6. Multiple 600 m by 8, and give the answer in both millimetres and metres.

7. Divide three metres into eight equal parts.
Section 4 – Obtaining measurements

Introduction

Everyone involved in the construction industry needs to be able to understand, obtain and use measurements accurately in a variety of situations, whether you need to read a plan to find out the height of a wall or check the width of a window frame before it’s loaded for delivery.

Being able to measure quickly, confidently and accurately is a valuable skill, as it will enable you to get the job done quickly and without mistakes – something all employers value.

Performance criteria

1.1 Work instructions are confirmed and applied using relevant information.

1.3 Measuring and calculating equipment selected to carry out tasks is consistent with job requirements, is checked for serviceability, and any faults are rectified or reported.

2.1 Method of obtaining the measurement is selected and applied.

2.2 Measurements are obtained using a rule or tape accurate to 1 mm.

2.3 Measurements, including areas and volumes, are confirmed and recorded.
Types of measurements

Let’s look at some of the different measurement types that you’ll need to be familiar with.

Linear measurements

Linear measurements measure lines or distances between two points. Common linear measurements include length, width, depth and height.

These are the most commonly used types of measurement in the construction industry. For example, wall and floor tilers use linear measurements to calculate the number of skirting tiles they need.
Perimeter

Perimeter is a boundary or outside edge. In the building industry it's used to refer to things like:

- fencing
- gutters
- external wall lengths.

Area

Area is the amount of space inside a boundary or outside edge. Square units are used for area measurements, such as metres squared ($m^2$). In the building and construction industry, area is used to determine things like the:

- floor area of a building, as a way of describing the size of the building
- wall and ceiling area, for quantities of tiles required to cover the walls in bathrooms, or the number of plasterboard sheets needed to cover a ceiling
- floor area of individual rooms, to determine the quantities of flooring or floor coverings required, e.g., floor tiles, timber flooring and vinyl
- roof area, to determine the number of roof tiles or amount of sheet roofing required
- area of a building block, to determine the minimum and/or maximum coverage to meet building regulations.

The shelving unit to be installed on a wall measures 1 m $\times$ 1 m. This means that the total area the front of the unit will cover is 1 $m^2$.

Area measurements are also used for the calculation of the number of bricks required to construct a wall, or for the number of pavers required for a path or driveway.
Circumference, radius and diameter

The perimeter of a circle is called its circumference \((c)\). The distance from the centre of a circle to any point on the circumference is called the radius \((r)\). The distance across the circle through the centre is called the diameter \((d)\) and equals twice the radius.

Decorative brickwork or tiling often requires calculations to be made in order to find the circumference of an area.

Activity 4.1 Linear measurements revision

Some information is missing. See if you can fill in the blanks.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
<th>Graphic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIRCUMFERENCE</td>
<td>The distance around the outside edge of a shape.</td>
<td>![Circumference Graphic]</td>
</tr>
<tr>
<td>RADIUS</td>
<td>The distance across the middle of a circle.</td>
<td>![Radius Graphic]</td>
</tr>
<tr>
<td>DIAMETER</td>
<td>The distance from the midpoint of a circle to the outer edge.</td>
<td>![Diameter Graphic]</td>
</tr>
</tbody>
</table>
Volume

The volume of an object is the amount of space it takes up in three dimensions. For example, when you buy a litre bottle of water, or order a truckload of sand, you're buying these items by volume. To measure volume, we use three-dimensional units or cubic units, such as mm$^3$ and m$^3$.

Calculations of volume in the construction industry are used to determine things like the amount of:

- soil to be excavated
- tile adhesive required
- sand to use in bricklayer’s mortar or a tiler’s screed
- tins and/or buckets of paint
- tubes of fixative required for a job
- concrete required to pour a slab.

Solid objects

For solid objects, volume is measured in cubic units, such as cubic metres (m$^3$). The little 3 that follows the ‘m’ in metres represents the three dimensions of a solid object, namely:

- the length
- the width
- the height.

Look at this example of a crate.

- The crate measures $1 \text{ m} \times 1 \text{ m} \times 1 \text{ m}$.
- This means that the volume of the box is one cubic metre (1 m$^3$).
Liquids

When measuring the volume of liquid, we use the litre (L) unit of measurement. For example:

- A 10-litre bucket of tile adhesive.
- Four-litre tins of paint.

It would take 1000 litres of water to fill a 1 m$^3$ container.

Mass

Mass is what we often call weight, or how heavy something is. It is measured in units such as grams (g) and kilograms (kg). Mass is used for many items in various trades – from a 25 kg bag of cement to a 100 kg glass-panel bifold door.

Different objects or substances have different masses, even if they have the same volume. For example, if you had to push a wheelbarrow of something up a ramp, which would you rather push – a wheelbarrow full of bricks or a wheelbarrow full of feathers?

Lifting heavy objects can be dangerous. In building and construction, you'll be required to lift materials, tools and equipment on a regular basis. Knowing the mass (weight) of an object will help to make sure you carry out these tasks safely.
Ways of obtaining measurements

There are several ways to obtain measurements. You can:

- read them off a plan or drawing
- measure them off a plan or drawing using a scale rule
- calculate them using other known measurements
- measure them physically using the appropriate tape measure
- read them from the packaging
- read them from the manufacturer’s instructions.

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### Activity 4.2 Obtaining measurements from plans: part 1

Study the Hopscotch Homes plan set provided at Annex C. Then circle the correct answer to each of the following questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
<th>Option D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The size of the home theatre is:</td>
<td>a) $5880 \times 3790$</td>
<td>b) $4100 \times 2800$</td>
<td>c) $4200 \times 3790$</td>
<td>d) $5880 \times 2110$</td>
</tr>
<tr>
<td>2. The size of Bed 4 is 3880 wide by:</td>
<td>a) 2320</td>
<td>b) 4770</td>
<td>c) 3820</td>
<td>d) not shown</td>
</tr>
<tr>
<td>3. The length of the kitchen bench to the right of the sink is:</td>
<td>a) 14 – 8</td>
<td>b) 2410</td>
<td>c) 1810</td>
<td>d) not shown</td>
</tr>
<tr>
<td>4. The number of light fixtures in the house is:</td>
<td>a) 28</td>
<td>b) 27</td>
<td>c) 7</td>
<td>d) not shown</td>
</tr>
<tr>
<td>5. The height of the bathroom window is:</td>
<td>a) 5 course</td>
<td>b) 12 course</td>
<td>c) 16 course</td>
<td>d) 20 course</td>
</tr>
<tr>
<td>6. The size of the linen cupboard is:</td>
<td>a) $1010 \times 510$</td>
<td>b) $1290 \times 720$</td>
<td>c) Lot 92 Bitter Way Beechboro</td>
<td>d) not shown</td>
</tr>
<tr>
<td>7. The roof overhangs the walls by:</td>
<td>a) 600 mm</td>
<td>b) 300 mm</td>
<td>c) 500 mm</td>
<td>d) unable to determine.</td>
</tr>
<tr>
<td>8. The number of 720-wide doors in the house is:</td>
<td>a) 2</td>
<td>b) 3</td>
<td>c) 4</td>
<td>d) 1</td>
</tr>
<tr>
<td>9. The width of the garage-attached piers is:</td>
<td>a) 250</td>
<td>b) 290</td>
<td>c) 350</td>
<td>d) not shown</td>
</tr>
<tr>
<td>10. The thickness of the concrete floor slab is:</td>
<td>a) 100 mm</td>
<td>b) 172 mm</td>
<td>c) 6 courses</td>
<td>d) 85 mm.</td>
</tr>
</tbody>
</table>
Activity 4.2 Obtaining measurements from plans: part 2

Pictured below is a detail drawing for a bathroom. Use your scale rule to measure the missing dimensions and write them in.

Scale 1:10

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Measuring accurately

Measurement is carried out almost every day and by almost all tradespeople. Whether you’re a carpenter, a wall and floor tiler, a bricklayer, a plasterer, a solid plasterer or a painter – or involved in any other kind of trades work within the building and construction industry, measurements will be required and performed no matter how big or small the job is.

Accurate measuring is very important, as incorrect measuring can result in wasted time which puts you behind schedule, wasted material which may cost you money to replace, or a less than aesthetic look on a completed job. For example, incorrectly sized tile cuts that are visible for all to see will not go over well with a client or employer.

Remember the saying, ‘measure twice – cut once’, as this may save you time and money.
Rounding off

Rounding off is reducing the number of digits in a measurement or calculation to the nearest decimal point or whole number. Most of the time, rounding off to two or three decimal places will be accurate enough for the calculations performed in the construction industry.

Here are a few things to consider when you're rounding off.

- How many digits will be kept? (In construction usually two or three.)
- If the following digit is less than five (5), the preceding digit stays the same. (For example, 23.4532 rounded off to three decimal places would be 23.453.)
- If the following digit is five (5) or higher, the last digit is increased by one. (For example, 24.4571 rounded off to two decimal places would be 24.46.)

Confirming measurements

Always check any measurements you’ve taken before you use them. That way if you’ve made a mistake, you can correct it before it’s too late.

Activity 4.3 Confirming measurements

With a partner or in a small group, think of five ways you could check calculations, measurements from other documentation, measurements from plans or physical measurements. Write your answers in the space below.

1. __________________________________________________________
2. __________________________________________________________
3. __________________________________________________________
4. __________________________________________________________
5. __________________________________________________________
Recording measurements

How you record a measurement will depend on how it's going to be used. Different tasks and different workplaces will have different requirements.

The most important thing is that all measurements, calculations or totals need to be recorded clearly and accurately, including using the correct units. It's important that anyone reading the information can understand it and rely on it.

Activity 4.4 Obtaining and recording physical measurements

Measure the following items around the building you're currently in. Use the appropriate piece of measuring equipment from the selection provided, and write your answers in the spaces below.

Remember to check that all equipment is in good working order before you begin.

**Safety note:** Remember to wear a hat, a long-sleeved shirt, sunglasses and sunscreen. Follow all other safety instructions given by your lecturer.

<table>
<thead>
<tr>
<th>Item</th>
<th>Equipment</th>
<th>Length</th>
<th>Width or height</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light switch from FFL</td>
<td></td>
<td></td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>Length of south wall</td>
<td></td>
<td></td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>Width of footpath</td>
<td></td>
<td>_</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of handrail</td>
<td></td>
<td>_</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car parking bay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front fence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Carry out measurements and calculations

CPCCM1015A
Section 5 – Using measurements in calculations

Introduction

We looked at linear measurements earlier in this guide. Linear measurements can be used as they are, or they can be used to calculate area and volume, the next two most frequently used measurements in the construction industry.

Performance criteria

2.1 Method of obtaining the measurement is selected and applied.
2.2 Measurements are obtained using a rule or tape accurate to 1 mm.
2.3 Measurements, including areas and volumes, are confirmed and recorded.
3.1 Appropriate calculation factors are determined and correct method is selected for achieving required result.
3.3 Results are confirmed and recorded.
Uses of different measurements

Now is a good time to check what you know already about different types of measurements.

Activity 5.1 Checking your knowledge of linear, square and cubic metres

Briefly explain the following measurement terms. The first one has been done for you as an example.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Used to measure</th>
<th>Example</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear metres</td>
<td>Length, height, width, depth</td>
<td>Length of a boundary, height of a window</td>
<td>mm or m</td>
</tr>
<tr>
<td>Square metres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cubic metres</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Activity 5.2 Linear, square or cubic?

Fill in the spaces to show whether each of the following is a linear, square or cubic measurement, and which unit is used for each one. Some examples have been provided for you.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Formula</th>
<th>Linear, square or cubic?</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter of a rectangle or square</td>
<td>( P = (\text{length} + \text{width}) \times 2 )</td>
<td></td>
<td>mm or m</td>
</tr>
<tr>
<td>Circumference of a circle</td>
<td>( C = \pi d )</td>
<td></td>
<td>mm or m</td>
</tr>
<tr>
<td>Area of a rectangle or square</td>
<td>( A = L \times W )</td>
<td></td>
<td>mm(^2) or m(^2)</td>
</tr>
<tr>
<td>Area of a circle</td>
<td>( A = \pi r^2 )</td>
<td>square</td>
<td></td>
</tr>
<tr>
<td>Area of a triangle</td>
<td>( A = \frac{1}{2} \text{ base} \times \text{perpendicular height} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Activity 5.3 How measurements are used

Discuss with a partner an example of where you might see each of the following measurements used in the construction industry. Make notes of what you come up with.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Example 1</th>
<th>Example 2</th>
<th>Example 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter of a rectangle</td>
<td>The perimeter of a rectangle is used to measure the total length of the sides of a rectangle in construction projects.</td>
<td>The perimeter of a rectangle is used to measure the total length of the sides of a rectangle in construction projects.</td>
<td>The perimeter of a rectangle is used to measure the total length of the sides of a rectangle in construction projects.</td>
</tr>
<tr>
<td>Circumference of a circle</td>
<td>The circumference of a circle is used to measure the distance around a circular object, such as a pipe or a cylinder, in construction.</td>
<td>The circumference of a circle is used to measure the distance around a circular object, such as a pipe or a cylinder, in construction.</td>
<td>The circumference of a circle is used to measure the distance around a circular object, such as a pipe or a cylinder, in construction.</td>
</tr>
<tr>
<td>Area of a circle</td>
<td>The area of a circle is used to calculate the space inside a circular object, such as a circular deck or a round table.</td>
<td>The area of a circle is used to calculate the space inside a circular object, such as a circular deck or a round table.</td>
<td>The area of a circle is used to calculate the space inside a circular object, such as a circular deck or a round table.</td>
</tr>
<tr>
<td>Area of a square</td>
<td>The area of a square is used to calculate the space inside a square object, such as a square table or a square window.</td>
<td>The area of a square is used to calculate the space inside a square object, such as a square table or a square window.</td>
<td>The area of a square is used to calculate the space inside a square object, such as a square table or a square window.</td>
</tr>
<tr>
<td>Area of a triangle</td>
<td>The area of a triangle is used to calculate the space inside a triangular object, such as a triangular roof or a triangular sign.</td>
<td>The area of a triangle is used to calculate the space inside a triangular object, such as a triangular roof or a triangular sign.</td>
<td>The area of a triangle is used to calculate the space inside a triangular object, such as a triangular roof or a triangular sign.</td>
</tr>
</tbody>
</table>

Calculations

Calculating the perimeter of a rectangle

A rectangle is any four-sided figure where all angles are $90^\circ$, and opposite sides are of equal length and parallel, as shown here.

For establishing formulas, we label the longer side $L$ (for length) and the shorter side $W$ (for width). If $P$ stands for the perimeter, we can write:

\[
P (\text{rectangle}) = L + W + L + W
\]

\[
= 2L + 2W
\]

\[
= 2(L + W)
\]

Therefore, the formula for calculating the perimeter of a rectangle is:

\[
P (\text{rectangle}) = 2(L + W)
\]
Example 1
Find the perimeter of the following rectangle.

\begin{align*}
\text{Solution:} \\
P (\text{rectangle}) &= 2(L + W) \\
&= 2(140 + 60) \text{ mm} \\
&= 2(200) \text{ mm} \\
&= 400 \text{ mm}
\end{align*}

Example 2
Find the perimeter of a rectangle whose length is 8 m and whose width is 4 m.

Solution:

Step 1
Draw a diagram.

\begin{align*}
\text{Step 2} \\
&\text{Write down the appropriate formula.} \\
P (\text{rectangle}) &= 2(L + W) \\
\text{Step 3} \\
&\text{Substitute numbers into the formula and calculate the answer.} \\
P (\text{rectangle}) &= 2(8 + 4) \text{ m} \\
&= 2(12) \text{ m} \\
&= 24 \text{ m}
\end{align*}
Section 5 – Using measurements in calculations

Activity 5.4 Finding perimeters

Calculate the following two perimeters. Show your working out in the space provided. Draw a simple diagram if it helps you. Convert your final answer into metres.

1. Find the perimeter of a rectangle with a base length of 4.5 m and a width of 3.5 m.

2. What would the perimeter of this brick wall be?

![Brick wall diagram]

3. When it’s finished, this table will need a thin beading applied around its top edge. If the table is 820 × 1240 mm, what length will the beading need to be?
Calculating more complex perimeters

Most houses aren’t just a simple rectangle, but you can use the same method as you just learned to work out their perimeters too.

Example 1

Have a look at this example of a house drawing.

Solution:

Perimeter of rectangle = 2(L + W)
= 2(6 + 4) m
= 20 m

Have a look at the shape to see why this method works even though the shape is not a basic rectangle.
Activity 5.5 Finding more complex perimeters

Calculate the perimeter of the shape below. Show your working out in the space provided.
Linear measurements

Calculating linear measurements is very similar to calculating the perimeter of an area, except you calculate only the length of the object or area required instead of the total perimeter.

For example, a carpenter needs to measure up a specific area in a new house where timber skirting is to be fixed. On the following drawing, the dotted lines indicate where timber skirting is to be fixed.

To calculate the linear measurement, ie the total length of skirting required, you simply add up each of the lengths. So that looks like:

\[ A \ 3.2 \ + \ B \ 3.5 \ + \ C \ 3.2 \ + \ D \ 4 \ + \ E \ 3 \]

\[ = \ 16.9 \ \text{Lm} \ \text{(lineal metres)} \]

The total can then be rounded off to 17 Lm of timber skirting required.

Always check any measurements you’ve taken before you use them. That way if you’ve made a mistake, you can correct it before it’s too late.
Calculating the circumference of a circle

Whenever a circle is drawn, no matter the size, it's always the case that the circumference is approximately 3.1416 times the diameter. We refer to this figure as ‘pi’, the Greek letter \( \pi \). The formula for finding the circumference of a circle is:

\[
C = \pi \times d
\]

where:

- \( C \) = circumference
- \( d \) = diameter
- \( \pi = 3.1416 \)

So, if the radius \( r \) in the circle shown here is 30 mm, then the diameter \( d \) would be 60 mm (ie \( 2 \times 30 \text{ mm} \)).
Example 1

Find the circumference of a grinding disc of diameter 50 mm.

Solution:

Step 1

Draw a diagram.

![Diagram of a grinding disc with diameter 50 mm]

Step 2

Write down the appropriate formula.

\[ C = \pi \times d \]

Step 3

Substitute numbers into the formula and calculate the answer.

\[ C = 3.1416 \times 50 \text{ mm} \]

\[ = 157.08 \text{ mm} \]
Example 2

Find the circumference of a circle of radius 35 mm.

Solution:

\[ \text{The radius } = 35 \text{ mm} \]
\[ \text{The diameter } = 2 \times 35 \text{ mm} \]
\[ = 70 \text{ mm} \]

Now \[ C = \pi \times d \]
\[ = 3.1416 \times 70 \text{ mm} \]
\[ = 219.9 \text{ mm} \]
Activity 5.6 Finding circumferences

Calculate the following two circumferences. Show your working out in the space provided. Draw a simple diagram if it helps you.

1. Find the circumference of a circle with a diameter of 100 mm.

2. Find the circumference of a circular pool with a radius of 12 m.
Calculating the area of a rectangle

The formula for finding the area of a rectangle is:

\[
A \text{ (rectangle)} = L \times W
\]

where:

- \(A\) = number of square units in the area
- \(L\) = length
- \(W\) = width

This is a 10 millimetre square.

This rectangle is 100 mm by 70 mm. So, if \(100 \times 70 = 7000\), then the area of this rectangle is 7000 \(m^2\).

Note: Length and width might also be called base and height, or length and breadth, depending on what the rectangle represents.

The length and the width must be measured in the same units.
Example 1
Find the area of a concrete floor which is 5000 mm in length and has a width of 3000 mm.
Solution:

\[ L = 5000 \text{ mm} \]

\[ W = 3000 \text{ mm} \]

\[ A(\text{rectangle}) = L \times W \]
\[ = (5000 \times 3000) \text{ mm}^2 \]
\[ = 15\,000\,000 \text{ mm}^2 \]
\[ = 15 \text{ m}^2 \]

Example 2
Find the area of a brick wall which is 2.5 m long and 0.5 m high.
Solution:

\[ L = 2.5 \text{ m} \]

\[ W = 0.5 \text{ m} \]

\[ A(\text{rectangle}) = L \times W \]
\[ = (2.5 \times 0.5) \text{ m}^2 \]
\[ = 1.25 \text{ m}^2 \]
Activity 5.7 Finding the area of a rectangle

Calculate the area of a rectangle 3.5 m high with a base of 6.2 m. Show your working out in the space provided. Draw a simple diagram if it helps you.

Calculating the area of a circle

The formula for calculating the area of a circle is:

\[ A (\text{circle}) = \pi r^2 \]

\[ = 3.1416 \times r \times r \]

or \[ \frac{\pi}{4} d^2 \]
**Example 1**

Find the area of a circle with a radius of 100 mm.

Solution:

\[
A\ (\text{circle}) = \pi r^2 \\
= (3.1416 \times 100 \times 100) \text{mm}^2 \\
= 31\ 416 \text{mm}^2
\]

**Example 2**

Find the area of a circle with a diameter of 7 m.

Solution:

Since the diameter = 7

then the radius = \( \frac{7}{2} = 3.5 \)

\[
A\ (\text{circle}) = \pi r^2 \\
= (3.1416 \times 3.5 \times 3.5) \text{m}^2 \\
= 38.485 \text{m}^2
\]
Section 5 – Using measurements in calculations

Activity 5.8 Calculating areas of circles

Calculate the following two areas. Show your working out in the space provided. Draw a simple diagram if it helps you.

1. Find the area of a circle with a radius of 600 mm.

2. Find the area of a circle with a diameter of 6.4 m.

Calculating the area of a triangle

The formula for calculating the area of a triangle is:

\[
A = \frac{1}{2} (B \times H)
\]

The base of a triangle may be on any of the three sides, but the height must be relative to the base at ninety degrees.
Example 1
Find the area of a triangle with a base of 16 m and a height of 5 m.
Solution:

\[
A \text{ (triangle)} = \frac{1}{2}(B \times H)
\]

\[
= \frac{1}{2}(16 \times 5) \text{ m}^2
\]

\[
= \frac{1}{2}(80) \text{ m}^2
\]

\[
= 40 \text{ m}^2
\]

Example 2
Find the area of a triangle with a base of 43 mm and a height of 12 mm.
Solution:

\[
A \text{ (triangle)} = \frac{1}{2}(B \times H)
\]

\[
= \frac{1}{2}(43 \times 12) \text{ mm}^2
\]

\[
= \frac{1}{2}(516) \text{ mm}^2
\]

\[
= 258 \text{ mm}^2
\]
Example 3
Find the area of the triangle below.
Solution:

\[
A_{\text{triangle}} = \frac{1}{2} (B \times H)
\]

\[
= \frac{1}{2} (4.2 \times 1.5) \text{ m}^2
\]

\[
= \frac{1}{2} (6.3) \text{ m}^2
\]

\[
= 3.15 \text{ m}^2
\]

Example 4
Find the area of the triangle below.
Solution:
Because this is a right-angled triangle, the side marked 5 mm also represents the height.
Carry out measurements and calculations

A (triangle) = \frac{1}{2} (B \times H)

= \frac{1}{2} (12 \times 5) \text{ mm}^2

= \frac{1}{2} (60) \text{ mm}^2

= 30 \text{ mm}^2

**Activity 5.9 Finding the area of triangles**

Calculate the following two areas. Show your working out in the space provided. Draw a simple diagram if it helps you.

1. Find the area of a triangle with a base of 520 mm and a height of 360 mm.

2. Calculate the area of this triangle.
Summary

Here are some key points to remember when calculating the area of a triangle.

- Height (H) is the distance (at 90º) from the base to the top point of the triangle.
- Base (B) can be any one of the three sides of a triangle, but the height must always be at the right angle (90º).
- To calculate the area of a triangle use the formula \( A = \frac{1}{2} (B \times H) \).

Calculating the hypotenuse of a triangle

The hypotenuse is the longest side of a right-angled triangle, opposite the right angle. The square of the hypotenuse is equal to the sum of the squares of the other two sides. This is useful to know, because once you have the lengths of the two sides of a right-angled triangle, you can work out the length of the longest side. But remember! This works only on right-angled triangles.

To calculate the hypotenuse, first square sides A and B, then add them together making C. To calculate C, we have to find its square root using a calculator.

When a number is squared, it is multiplied by itself, eg ‘two squared’ means 2 × 2, so two squared equals four.

Look at the example below.

As a formula, this is:

\[ A^2 + B^2 = C^2 \]

Example

\[ A^2 = 8.8 \text{ m} \times 8.8 \text{ m} = 77.44 \]
\[ B^2 = 7.8 \text{ m} \times 7.8 \text{ m} = 60.84 \text{ m} \]
\[ A^2 + B^2 = 60.84 + 77.44 = 138.28 \]
To get to $C^2$, we have to find the square root of $A^2 + B^2$; however, calculating square root is very complex! Use the square root button (looks like $\sqrt{\phantom{0}}$) on your calculator to get the answer you need.

$$C^2 = \sqrt{138.28}$$

$$= 11.759251 \text{ m}$$

We round off the answer to three decimal places to get the hypotenuse of the triangle, namely 11.759 m.

**Activity 5.10 Calculating the hypotenuse**

Use the formula to calculate the hypotenuse of this triangle. Show your working out in the space provided, and round off your answer to three decimal places.

**Solution**

$$A^2 + B^2 = C^2$$

$$A^2 =$$

$$B^2 =$$

$$A^2 + B^2 =$$

$$C^2 = \sqrt{\phantom{0}}$$

$$=$$
Calculating the area of a trapezium

A trapezium is a four-sided flat shape with straight sides. One pair of its opposite sides will be in parallel. In the trapezium pictured below, the parallel sides are indicated.

![Trapezium Diagram](image)

The area of a trapezium equals half the sum of the parallel sides, times the height between them. As a formula, this is:

$$A = \frac{1}{2}(A + B) \times H$$

**Example**

In this trapezium,

$$A = \frac{1}{2}(4 + 12) \times 8$$

$$= \frac{1}{2}(16 \times 8)$$

$$= \frac{1}{2}(128)$$

$$= 64 \text{ mm}^2$$
Activity 5.11 Calculating the area of a trapezium

Using the formula, calculate the area of this trapezium. Show your working out in the space provided, and round off to m².

Solution

\[ A = \frac{1}{2} (A + B) \times H \]

Calculating the area of compound shapes

With contemporary home designs, you often have to calculate the area of more complex shapes in both interior and exterior areas. All homes have windows and doors; some may have triangular sections on roofs, while others may include design features in a range of shapes and sizes.

To calculate the area of more complex shapes, you need to divide them into shapes whose area can be calculated more easily, eg rectangles or squares.
Take a look at this floor plan. It’s an L-shape which makes it difficult to calculate the area.

Divide the floor into sections of shapes that are easier to work with. With this shape, there are two ways you can do that.

By dividing this complex shape into two simple shapes, it’s now much easier to calculate the total area.
Example 1

Find the area of this shape.

Solution:

Area of rectangle A = width × height
= (3 × 2.5) m²
= 7.5 m²

Area of rectangle B = width × height
= (6 × 1.5) m² (since the width = 2 + 3 + 1 m)
= 9 m²

Total area of rectangles = A + B
= (7.5 + 9) m²
= 16.5 m²
Example 2

Find the area of the shaded region in this shape.

Solution:

Since the circle has a radius of 30 mm, its diameter must be 60 mm.

Furthermore, since the diameter of the circle extends to the sides of the square, then the sides of the square must also be 60 mm long.

Area of square $= W \times H$

$$= (60 \times 60) \text{ mm}$$

$$= 3600 \text{ mm}^2$$

Area of circle $= \pi r^2$

$$= 3.1416 \times 30 \times 30 \text{ mm}$$

$$= 2827.44 \text{ mm}^2$$

Area of shaded region $= \text{area of square – area of circle}$

$$= (3600 – 2827.44) \text{ mm}^2$$

$$= 772.56 \text{ mm}^2$$

When the area of part of a region or shape is subtracted from the area of the overall region or shape, the answer is known as the net surface area. This is used for things like calculating the number of bricks required for a wall minus the area of the openings (windows and doors), or the paving required for a courtyard minus the area of garden beds.
Activity 5.12 Finding areas of compound shapes

Calculate the following two areas. Show your working out in the space provided.

1. Find the area of this shape.

   ![Diagram of a compound shape]

   - Lengths: 30 m, 40 m, 50 m, 70 m

2. Find the area of the shaded part of this shape.

   ![Diagram of a compound shape with a shaded area]

   - Lengths: 16 m, 6 m, 2 m
3. Calculate the net surface area (shaded part) of the wall in the sketch below. The wall height is 2450. The door is 2040 \times 820 and the window 940 \times 1200.

<table>
<thead>
<tr>
<th>Door</th>
<th>Window</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>6300</td>
<td></td>
</tr>
</tbody>
</table>

**Formula**

**Answer**

**Summary**

Here are some key points to remember about calculating the area of complex shapes.

- Break or divide shapes into separate sections of regular shapes.
- Use the same formula as you would to work out the m² of a rectangle or square (width \times height).
- Where there are openings such as windows and doors in a wall, subtract those from the total area of the wall to calculate the net surface area.
- Always round your answer off to three decimal places.
Calculating volume

Calculations of volume in building and construction are used to determine things like the:

- volume of soil to be excavated from the foundation for footings
- volume of soil to be removed from a sloping site to provide a level area to build on
- amount of material required as fill, eg under floor slabs
- quantity of materials required for a particular job, eg cubic metres of sand for use in bricklayer’s mortar
- volume of concrete needed for strip footings and slabs.

Calculating the volume of a prism

A prism is a solid shape with two identical ends that are the same size and shape and parallel to each other. Rectangles and squares are the most common prism shapes you’ll deal with in building and construction. To calculate the volume of a prism, you multiply its area by its height. As a formula, it is:

\[ V = A \times H \]

Volume is always in cubic metres (m³).

For a rectangular solid, since the base is a rectangle:

\[ A \text{ (rectangle)} = L \times W \]

So \[ V \text{ (rectangular solid)} = L \times W \times H \]
Rectangular prism

You'll often need to calculate the volume of a rectangular solid. For example, let's look at a project where a large home theatre room is being built as an extension to an existing home. The new room is a rectangular shape, and you have to work out how much concrete will be required for the slab.

You already know that the formula used to calculate the area of a rectangle is \( A = L \times W \). The formula you use when calculating the volume of a rectangular solid is:

\[
V = L \times W \times H
\]

The slab in the new room has a length of 7 m, and a width of 3 m. Its height will be 170 mm, to fit with the existing house. To calculate the volume, your working out would be as follows.

\[
V = L \times W \times H = 7 \times 3 \times 0.17 = 3.57 \text{ m}^3
\]

Example 1

Calculate the volume of the rectangular box shown here.

Solution:

\[
V(\text{rectangular solid}) = L \times W \times H = 3 \times 7 \times 11 \text{ m}^3 = 231 \text{ m}^3
\]
Example 2

Calculate the volume of sand needed to fill this trench.

Solution:

\[ V (\text{rectangular solid}) = L \times W \times H \]

\[ = (0.5 \times 1.5 \times 5) \text{ m}^3 \]

\[ = 3.75 \text{ m}^3 \]

Activity 5.13 Finding volume

Calculate the following two volumes. Show your working out in the space provided. Draw a simple diagram if it helps you.

1. Calculate the volume of the rectangular box shown here.
2. Calculate the volume of cement needed for a driveway which is 10 m long, 3 m wide and 100 mm deep.

Calculating the volume of a cylinder

You may be required at times to calculate the volume of a cylinder. For example, if a home has a portico with columns or pillars at the entrance, those are generally supplied as compressed cement hollow cylinders that have to be filled with cement then painted or rendered.

You already know that the formula used to calculate volume is \( V = A \times H \), and that to calculate the area of a circle, the formula is \( A = \pi r^2 \). The volume of a cylinder is worked out by \( \pi \times \text{radius squared} \times \text{height} \); as a formula, that’s:

\[
V = \pi r^2 \times H
\]

Remember to halve the diameter to find the radius.

Example

Work out in steps the volume of sand needed to fill this cylinder. First convert the height and diameter from millimetres to metres.

\( H = 1.6 \text{ m} \)

\( D = 2.8 \text{ m} \)

Then halve the diameter to get the radius.

\[ D = 2.8 \text{ m} \]
\[ 2.8 \div 2 = 1.4 \text{ m} \]
\[ R = 1.4 \text{ m} \]
Now use $V = \pi r^2 \times H$ to work out the volume of the cylinder.

$$3.142 (\pi) \times 1.4 \times 1.4 \times 1.6$$

$$V = 9.853 \text{ m}^3$$

Always round off to three decimal places.

**Activity 5.14 Calculating volume of a cylinder**

Calculate the volume of this cylinder.

Find the volume of a cylinder with a height of 2400 and a diameter of 1200. Show your working out.
Calculating the volume of a pyramid

The calculation for finding the volume of a pyramid is the length × width × height then divide by three. As a formula, that's:

\[ V = L \times W \times H \div 3 \]

Example

\[
L \times W \times H \div 3 \\
2.4 \text{ m} \times 2.4 \text{ m} \times 3.2 \text{ m} \div 3 \\
= 6.144 \text{ m}^3
\]

Activity 5.15 Calculating the volume of a pyramid

Calculate the volume of a pyramid with a height of 4 m, width of 3 m and length of 3 m. Show all working out using the formula.

Calculate the volume of a pyramid with a height of 2.6 m, width of 3 m and length of 3 m. Show all working out using the formula.
Calculating mass

You may be required to calculate the mass of objects for the purpose of organising lifting equipment. To do this, you would use the formula:

\[ V \times \text{(mass of materials per cubic metre)} \]

or

\[ L \times W \times H \times \text{(mass of material per cubic metre)} \]

Example

Your boss has asked you to take the ute and pick up a box full of aluminium sheeting. To work out how heavy this will be, we know that aluminium has a mass of 2700 kg per cubic metre, and that the box measurements are 4 m × 3 m × 2 m. This means that the box is a rectangular solid. We need to use \( L \times W \times H \) to work out the volume.

\[
V = L \times W \times H \\
= 4 \times 3 \times 2 \text{ m}^3 \\
= 24 \text{ m}^3
\]

We now know that the volume of the box is 24 m\(^3\). From that, we can work out the mass of the box filled with aluminium.

\[
\text{Mass} = V \times \text{(mass of material per m}^3\text{)} \\
= 24 \text{ m}^3 \times 2700 \text{ kg (mass)} \\
= 64800 \text{ kg}
\]
Activity 5.16 Calculating mass

Calculate the following two masses for the same box. Show your working out in the space provided. Draw a simple diagram if it helps you.

1. Find the mass of the box when it's filled with solid concrete. Concrete has a mass of 2400 kg per cubic metre.

2. Find the mass of the box when it's filled with solid mild steel. Mild steel has a mass of 7850 kg per cubic metre.
Ratio

Ratio is used regularly in the building and construction industry. It is the relationship between two or more numbers or amounts, with the ‘:’ representing ‘to’. It can be expressed as:

- the ratio of A to B to C
  or
- A:B:C.

Ratios are used for things like:

- mixing mortar (bricklayers, wall and floor tilers, solid plasterers)
- expressing slope (degree of angle)
- drawing to scale
- thinning paint.

For example, the standard ratio for a mortar mix is 6:1:1. This means:

- six parts sand
to

- one part lime
to

- one part cement.

However, from this example you can see that the ratio doesn’t tell you how much cement or sand to use in a mortar mix, or how much concrete is being made – just the relationship of the amount of cement to sand to lime.

Activity 5.17 Practising ratios

Pictured below are tins of blue paint, and tins of red paint. What is the ratio of blue to red?

Ratio =  

[Image of tins of blue and red paint]
Other units of measurement

Some materials and products aren’t measured using metric units. Sometimes in the construction industry, a term more specific to the industry and/or the type of material or product will be used to express quantity.

Activity 5.18 Other quantities and units

Read through these examples of quantities and units of measurement. Then try to think of another example of something measured the same way and write it into the last column. If you’re not sure of some, check with your lecturer. Some answers have been done for you.

<table>
<thead>
<tr>
<th>Material or product</th>
<th>Quantity/container</th>
<th>Measure/unit</th>
<th>Another example material or product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber – general</td>
<td>Lengths and packs</td>
<td>mm in 300 mm increments, eg 1800 mm, 2100 mm, 2400 mm</td>
<td></td>
</tr>
<tr>
<td>Timber – sheets (eg ply, veneer)</td>
<td>Sheets and packs</td>
<td></td>
<td>Polycarbonate sheeting</td>
</tr>
<tr>
<td>Timber – cross-sectional sizes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bricks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td></td>
<td>Cubic metre, m³</td>
<td></td>
</tr>
</tbody>
</table>
Carry out measurements and calculations

CPCCM1015A
Section 6 – Calculating quantities

Introduction

Quantity is a term used in the building industry for the number or amount of materials required for a particular task. For instance, before constructing the roof frame for a house, a carpenter must be able to calculate the sizes, lengths and amount of timber needed so that the correct quantities can be ordered from the supplier.

Performance criteria

3.1 Appropriate calculation factors are determined and correct method is selected for achieving required result.

3.2 Material quantities for the project are correctly calculated using appropriate factors.

3.3 Results are confirmed and recorded.

4.1 Calculations for determining material requirements are taken.

4.2. Appropriate formulas for calculating quantities are selected.

4.3. Quantities are estimated from the calculations taken.

4.4. Material quantities for the project are calculated, confirmed and recorded within enterprise tolerances.

Now that you know how to take measurements for materials you might need to use, it's time to put it all together by calculating quantities.

Bricks and mortar

Calculating how many bricks are needed to build a wall is a multi-step process. We’re going to work through how to do that now. Then we’ll calculate the materials needed to make the mortar.

Image reproduced courtesy of Housing Industry Association Ltd.
Bricks

The wall we’re going to work out is the west wall on the drawing below, and just the external leaf (the outside wall). We’re going to assume an external wall height of 2400, and that standard bricks will be used.

Step 1: Identify the wall
Use the north point to determine that the west wall is on the left-hand side of the plan.

Step 2: Find the length of the wall
The wall hasn’t been dimensioned, so we’ll have to measure it using a scale rule. We can see that the floor plan has been drawn at a scale of 1:100 (100 times smaller than real life) so we need to use the side of the scale rule showing 1:100.
The scale rule says that the length of the wall is 6950. Can you just go ahead and use that?

What do you need to check before using a measurement scaled from a plan?

You need to make sure that the drawing has been printed at the right size. You can do this by finding something on the drawing that has been dimensioned, and checking if the measurement on the scale rule matches the dimension. In this case you can see that the north wall dimension is 11 030. Put your scale rule against that wall and see if it’s correct.

It is, so you can trust that the length of the west wall is 6950.
Step 3: Calculate the area

Draw a diagram of the wall to help.

![Diagram of wall measurements]

Step 4: Check the units

We usually measure area in square metres (m²), so let's convert those dimensions from millimetres to metres first, so we can calculate the area more easily. To do that, we move the decimal point three places to the left, so 6950 mm becomes 6.95 m, and 2400 mm becomes 2.40 m.

Step 5: Apply the formula

Area (rectangle) = W × H
= 6.95 × 2.40
= 16.68 m²

Step 6: Determine bricks per square metre (m²)

Now that we know the area of the wall to be built, it's time to work out how many bricks are needed. The first part of doing that is to find out how many bricks are needed to build 1 m² of wall. To do that, we need to know what kind of bricks are being used and then check the manufacturer's information on those bricks.

The table that follows shows the kind of information you would find on a brick manufacturer's website – it shows how many bricks of each size are needed for 1 m² of wall. The one that's in bold (76 × 230) is a standard brick, which is the size we're using. The table tells us that for every square metre of wall we want to build, we'll need 48.5 bricks.
### Step 7: Calculate brick quantity

To work this out, we simply multiply the number of square metres of wall by the number of bricks required per square metre.

- **Square metres of wall** = 16.68
- **Bricks required per square metre** = 48.5
- Multiply 16.68 × 48.5 = 808.98

We can’t order 0.98 of a brick, so we’ll need to round that number up to 809 bricks.

**Solution:** 809 bricks are needed to build the west wall.

---

**Note:** When ordering bricks for a job, an allowance also needs be made for wastage – bricks that will be wasted during construction – so the quantity ordered for this job would actually be more than 809 bricks.

Brick suppliers provide their bricks in different ways, eg on pallets or just wrapped for a forklift to pick up. This may require bricks to be ordered in specific quantities, such as hundreds or thousands.
Activity 6.1 Calculating brick quantity

Follow the steps in the example we just completed to work out how many bricks will be needed to build the west wall of this house. Show your working out in the space below.
Mortar

Cement, lime and sand are used to make mortar. The manufacturer’s mortar table below tells us the ratio of cement to lime to sand required.

<table>
<thead>
<tr>
<th>Mortar</th>
<th>Cement</th>
<th>Lime</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3 mortar – GP cement + Hy Lime</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

The ratio of cement to lime to sand shown in the table above is 1:1:6. This means that for every one bucket (or barrow load or shovel full) of cement in the mortar mix, we need to add the same amount of lime and six times that amount of sand, which is a calculation involving ratio for quantities.

Concrete

Concrete quantities are calculated as a volume, and measured in cubic metres (m$^3$). Working out how much concrete is needed for the slab to a building is a multi-step process.

FLOOR PLAN
SCALE 1:100
Step 1: Choose the formula

Volume = L \times W \times H

When we’re talking about a slab, the ‘height’ refers to the thickness of the concrete. The engineer determines how thick the slab needs to be – in this case it’s 100 mm – so we just need to get the other two dimensions from the floor plan – the length and the width.

Step 2: Convert the units

Volume is calculated in cubic metres, so we need all three measurements to be in metres. We have the length and width in metres already, but we’ll have to convert the slab height from millimetres to metres. To convert millimetres to metres, we move the decimal point three places to the left to make the number 1000 times smaller. For example:

Start with 100 mm.

Move the decimal point three times to the left.

It becomes 0.10 m.

Step 3: Apply the formula

Volume = L \times W \times H

\[
= 11.03 \times 6.95 \times 0.10
\]

\[
= 7.66585 \text{ m}^3
\]

Step 4: Wastage

Even the most careful and well-calculated jobs will have some wastage. When calculating the volume of concrete required, a percentage is added to the total to allow for irregular forms, varying thickness, and losses caused by spilling when transporting and depositing the concrete. The typical wastage allowance for concrete poured on the ground is 10%. This means we need to calculate and add an amount of 10% more concrete to the volume required.

Volume calculated (see above) = 7.66585 \text{ m}^3

\[
7.66585 \times 10\% = 0.766585 \text{ m}^3
\]

\[
7.66585 + 0.766585 = 8.432435 \text{ m}^3
\]

Step 5: Round up the number to give the answer

Obviously no-one can measure concrete completely accurately to six decimal places as calculated above, so our answer needs to be given to two decimal places, and we need to round up. That means that in our example, the amount of concrete required for the slab is 8.44 \text{ m}^3.
Activity 6.2 Calculating the volume of concrete

Follow the steps in the example we just completed to work out the volume of concrete required to pour a 100 mm slab for this house. Show your working out in the space below.

FLOOR PLAN
Tiles

Tiles are also measured in square metres (m²), though there are some circumstances where it may be necessary for lineal measurements to be carried out, eg when fixing a single row of tiles along the base of a wall all around a room. In this case, we would measure only the length of tiles laid. This is very similar to measuring the perimeter.

Calculating quantity of tiles for walls and floors

Calculating tile quantity for walls and floors involves seven steps. To see how these steps fit together, let’s start with the following drawing. Here we see a bathroom that needs wall tiles. In this example, we use height (H) rather than width, as it’s a vertical wall.

Step 1: Calculate the area of the wall to be tiled

Take the measurements of the wall, and calculate the area using the formula for a rectangle \( A = L \times H \).

\[
\text{Length of tiles along wall} = 3200 \text{ mm}
\]

\[
\text{Finished tile height} = 1200 \text{ mm}
\]

Step 2: Check the units

We usually measure area in square metres (m²), so let’s convert those dimensions from millimetres to metres first so we can calculate the area more easily. To do that we move the decimal point three places to the left, so 1200 mm becomes 1.20 m, and 3200 mm becomes 3.20 m.

Step 3: Apply the formula

\[
\text{Area} = L \times H
\]

\[
= 3.20 \times 1.20
\]

\[
= 3.84 \text{ m}^2
\]
Step 4: Determine wall tiles per square metre (m²)

Now we have the area of the wall to be tiled, it’s time to work out how many wall tiles we’ll need. The first part of doing this is to find out how many tiles are needed to tile one square metre of wall. To do that, we need to know what kind of tiles are being used then check the manufacturer’s information.

The following table shows the kind of information you would find on the tile manufacturer’s website – it shows how many tiles of each size are needed for 1 m² of wall or floor. The tile that’s in bold (200 × 200) is a standard tile and is the size we’re using. 200 x 200 means that the tile is 200 mm on all four sides. The table tells us that for every square metre of wall we want to fix, we need 25 tiles.

<table>
<thead>
<tr>
<th>Square tiles</th>
<th>per m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 × 100</td>
<td>100</td>
</tr>
<tr>
<td>150 × 150</td>
<td>44</td>
</tr>
<tr>
<td><strong>200 × 200</strong></td>
<td><strong>25</strong></td>
</tr>
<tr>
<td>225 × 225</td>
<td>20</td>
</tr>
<tr>
<td>300 × 300</td>
<td>11</td>
</tr>
<tr>
<td>400 × 400</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oblong tiles</th>
<th>per m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 × 75</td>
<td>88</td>
</tr>
<tr>
<td>200 × 100</td>
<td>50</td>
</tr>
<tr>
<td>225 × 112</td>
<td>40</td>
</tr>
<tr>
<td>225 × 150</td>
<td>30</td>
</tr>
</tbody>
</table>

Step 5: Wastage

Even the most careful and well-calculated jobs will have some wastage. When calculating the square metre of tiles required, a percentage is added to the total to allow for broken and/or damaged tiles when delivered, and tiles that will be wasted during the tiling process through cutting. The typical wastage allowance for tiling is 10%.

This means we need to calculate and add an amount of 10% more tiles for this job.

Area of wall to be tiled calculated = 3.84 m²

\[ 3.84 \times 10\% \text{ (wastage)} = 0.384 \]

\[ 3.84 + 0.384 = 4.224 \text{ m}^2 \]
Step 6: Calculate tile quantity

To work out the quantity of tiles required, multiply the number of square metres of wall by the number of tiles required per square metre. From our earlier calculations in steps 3 and 5, we know that there’s 4.224 m² area of wall. From step 4, we know that 25 tiles per square metre will be required. We multiply area by tiles to get the total:

\[ 4.224 \times 25 = 105.6 \]

We now know that 105.6 tiles are needed to tile the bathroom wall.

Step 7: Round up the number to get the answer

The answer needs to be given to two decimal places, and you have to round up. That means that in this example, the total amount of tiles required to tile the bathroom wall equals 4.23 m², and you would need 106 tiles.

Activity 6.3 Quantities of tiles

Liam needs to work out how many tiles he needs for the floor area he’s working on. Follow the seven steps to work out what the total area is, and how many tiles he’ll need.

Specifications

Floor area to be tiled: 4890 (L) × 4460 (W)
Size of each floor tile: 300 × 300 mm
Show your working out in the space below.
Timber

In this drawing, you can see the site plan for a new home currently under construction. The owners of the house want a fence around the back garden to keep their small children safe.

We need to calculate how many fence posts – at maximum 1800 centres – are required to fence the garden. Like the previous calculations we’ve done, this one also requires several steps.
Step 1: Work out the length of each section to be fenced

We know the length of the rear boundary is 17.03 m, but the rest of the area to be fenced hasn’t been dimensioned on the site plan – only the actual boundaries have. So we’ll have to measure the plan using a scale rule to work out those lengths. We can see that the site plan has been drawn at a scale of 1:200 (200 times smaller than real life) so we need to use the side of the scale rule showing 1:200.
The scale rule tells us that the length of fence needed for the east side is 15 m. Can we just go ahead and use that?

What do we need to check before using a measurement scaled from a plan?

We always need to make sure the drawing has been printed at the right size. We can do this by finding something on the drawing that has been dimensioned and checking whether the measurement on the scale rule matches the dimension. In this case, we can see that the north boundary dimension is 17.03 m. Put your scale rule against that line and see if it’s correct.

It is, so we can trust our scaled measurement of the east fence line, and find the other measurements we need using our scale rule.

We don’t need to measure the length to be fenced on the west side, as this block is rectangular, so it’s the same as the east – 15 m. We also don’t need to measure the two short sections between the front corners of the house and the side boundaries, because those distances are the same as the side setback dimensions – 1500 and 4500.

**Step 2: Calculate the total length to be fenced**

Adding up all those measurements will give us the total length that needs to be fenced.

\[ 17.03 \text{ m} + 15.00 \text{ m} + 15.00 \text{ m} + 1500 \text{ mm} + 4500 \text{ mm} \]

It will be easier to add this up if all the measurements are in the same unit, so let’s convert the 1500 and 4500 to metres. To do that, we just need to move the decimal point three places to the left.

\[ 17.03 + 15.00 + 15.00 + 1.50 + 4.50 = 53.03 \text{ m} \]
Step 3: Work out the number of posts required

To work out how many posts are needed, we can just divide the total length by the required distance between centres. So 53.03 m divided by 1800 mm, or 1.8 m if we convert that distance to metres, right?

Not quite. If this were just one straight piece of fence that was 53.03 m long, that method would work, but it isn’t. Have a look at this sketch of where the fence is going, and see if you can figure out why.
What is needed at the corners and where the fence meets the house?

**Step 4: Corner posts**

Wherever the fence ends or changes direction, a corner post is required. So this fence will need six corner posts. Have a look at this sketch to see where they go.

As you can see, there is a post at each corner and one at each point where the fence meets the house.
Step 5: East side fence posts

Next we need to work out how many posts are needed for each section of fence. Let's start with the east boundary. Remember that the maximum spacing for the posts is 1800 centres. So we need to space the posts out along the boundary with no more than 1800 mm from the centre of one post to the centre of the next. So let's divide the length to be fenced by the spacing.

\[ \frac{15000}{1800} = 8.33 \]

That means we'll have eight spaces of 1800 mm each, and one of about 600 mm. The owner might want the posts spaced evenly instead, or having two close together might work for them to fix something to, like a seat. The installer will check that before digging.

This sketch shows how it could be done with 10 posts. Note the dimensions of the space between each post.
Step 6: Remaining posts

We can use the same method to work out the number of posts and spacings for the remaining four lengths of fence. Alternatively, if the sketch we drew was to scale, we could measure and draw in all the posts along the entire fence line, which would look something like this.
Step 7: Add them up

The last thing we need to do is add up the total number of posts required, as follows:

<table>
<thead>
<tr>
<th>Side</th>
<th>Posts</th>
</tr>
</thead>
<tbody>
<tr>
<td>East side</td>
<td>10</td>
</tr>
<tr>
<td>North side</td>
<td>10</td>
</tr>
<tr>
<td>West side</td>
<td>9</td>
</tr>
<tr>
<td>South side (left)</td>
<td>1</td>
</tr>
<tr>
<td>South side (right)</td>
<td>3</td>
</tr>
</tbody>
</table>

Total = 33

So we need 33 posts in total.

Sometimes it's a good idea to use both methods – calculating and sketching – as a way of double-checking and avoiding errors.
Activity 6.4 Calculating the number of fence posts needed

Follow the steps in the example we just completed to work out how many fence posts are needed to fence the rear garden of this Sanderson Street house in the same way. Show your working out in the space below.
Carry out measurements and calculations
Section 7 – Reflection and evaluation

Performance criteria
All

Introduction
In this unit, we have looked at how to carry out measurements and calculations for residential buildings.

Evaluation
This is the last activity for this unit and is a reflection on what you've learned. Take a few minutes to complete the questions in the table and the answers will be discussed as a class group.
### Activity 7.1

<table>
<thead>
<tr>
<th>Element</th>
<th>Do you have an understanding of these areas? Yes / No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element 1</strong></td>
<td>Plan and prepare</td>
</tr>
<tr>
<td><strong>Element 2</strong></td>
<td>Obtain measurements</td>
</tr>
<tr>
<td><strong>Element 3</strong></td>
<td>Perform calculations</td>
</tr>
<tr>
<td><strong>Element 4</strong></td>
<td>Estimate approximate quantities</td>
</tr>
</tbody>
</table>

In your opinion, have the stated outcomes for this unit been met?

Has this unit given you the confidence to consider a career in the residential building industry?

Are there any improvements that you can suggest for this unit for the benefit of future classes?

Thank you for participating in this unit. We wish you well for your future career path. Please talk to your lecturer if you need any more information on pathways and study options.
Annex A – Unit details

<table>
<thead>
<tr>
<th>Unit title</th>
<th>Carry out measurements and calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptor</td>
<td>This unit of competency specifies the outcomes required to carry out measurements and perform simple calculations to determine task and material requirements for a job in a construction work environment.</td>
</tr>
<tr>
<td>Employability skills</td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td>Prerequisite units</td>
<td>Nil</td>
</tr>
<tr>
<td>Application</td>
<td>This unit of competency supports achievement of skills to take measurements and use these to calculate material qualities and calculations for related tasks commonly used and applied in construction work.</td>
</tr>
</tbody>
</table>

Element 1 Plan and prepare

1.1 Work instructions are confirmed and applied using relevant information.

1.2 Safety (OHS) requirements are obtained from site safety plan, other regulatory specifications or legal obligations, and are applied.

1.3 Measuring and calculating equipment selected to carry out tasks is consistent with job requirements, is checked for serviceability, and any faults are rectified or reported.

Element 2 Obtain measurements

2.1 Method of obtaining the measurement is selected and applied.

2.2 Measurements are obtained using a rule or tape accurate to 1 mm.

2.3 Measurements, including areas and volumes, are confirmed and recorded.

Element 3 Perform calculations

3.1 Appropriate calculation factors are determined and correct method is selected for achieving required result.

3.2 Material quantities for the project are correctly calculated using appropriate factors.

3.3 Results are confirmed and recorded.
Element 4 Estimate approximate quantities

4.1. Calculations for determining material requirements are taken.
4.2. Appropriate formulas for calculating quantities are selected.
4.3. Quantities are estimated from the calculations taken.
4.4. Material quantities for the project are calculated, confirmed and recorded within enterprise tolerances.

Required skills and knowledge

Required skills

Required skills for this unit are:

- communication skills to:
  - determine requirements
  - enable clear and direct communication, using questioning to identify and confirm requirements, share information, listen and understand
  - follow instructions
  - read and interpret:
    - documentation from a variety of sources
    - drawings and specifications
  - report faults
  - use language and concepts appropriate to cultural differences
  - use and interpret non-verbal communication, such as hand signals
  - written skills to record measurements, calculations and quantities

- identifying and accurately reporting to appropriate personnel any faults in tools, equipment or materials

- numeracy skills to apply measurements, calculations and geometry

- organisational skills, including the ability to plan and set out work

- teamwork skills to work with others to action tasks and relate to people from a range of cultural and ethnic backgrounds and with varying physical and mental abilities

- technological skills to:
  - use a range of mobile technology, such as two-way radio and mobile phones
  - voice and hand signals to access and understand site-specific instructions.
Required knowledge

Required knowledge for this unit is:

• basic calculators
• communication devices
• company procedures
• construction terminology
• job safety analysis (JSA) and safe work method statements
• measuring, calculating, geometry and determination of quantities
• processes for care of measuring equipment
• project quality requirements
• site and equipment safety (OHS) requirements
• tolerances.
# Evidence guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

<table>
<thead>
<tr>
<th>Overview of assessment</th>
<th>This unit of competency could be assessed in the workplace or a close simulation of the workplace environment, provided that simulated or project-based assessment techniques fully replicate construction workplace conditions, materials, activities, responsibilities and procedures.</th>
</tr>
</thead>
</table>
| Critical aspects for assessment and evidence required to demonstrate competency in this unit | A person who demonstrates competency in this unit must be able to provide evidence of the ability to:  
  • locate, interpret and apply relevant information  
  • comply with site safety plan, OHS regulations and state and territory legislation applicable to workplace operations  
  • comply with organisational policies and procedures, including quality requirements  
  • safely and effectively use tools and equipment  
  • communicate and work effectively and safely with others  
  • complete measurements, calculations and determination of quantities for different projects of varying complexity in a range of contexts or occasions over time  
  • calculate each of the following using a realistic construction task or example:  
    ◦ length  
    ◦ perimeter  
    ◦ circumference  
    ◦ area  
    ◦ volume  
    ◦ number  
    ◦ ratio  
    ◦ percentage  
    ◦ conversion of metres to millimetres and millimetres to metres  
    ◦ measure using a rule or tape measure five separate tasks within 1 mm accuracy. |
<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>This competency is to be assessed using standard and authorised work practices, safety requirements and environmental constraints. Assessment of essential underpinning knowledge will usually be conducted in an off-site context. Assessment is to comply with relevant regulatory or Australian standards' requirements. Resource implications for assessment include:</td>
</tr>
<tr>
<td>- an induction procedure and requirement</td>
</tr>
<tr>
<td>- realistic tasks or simulated tasks covering the mandatory task requirements</td>
</tr>
<tr>
<td>- relevant specifications and work instructions</td>
</tr>
<tr>
<td>- tools and equipment appropriate to applying safe work practices</td>
</tr>
<tr>
<td>- support materials appropriate to activity</td>
</tr>
<tr>
<td>- workplace instructions relating to safe work practices and addressing hazards and emergencies</td>
</tr>
<tr>
<td>- material safety data sheets</td>
</tr>
<tr>
<td>- research resources, including industry-related systems information.</td>
</tr>
</tbody>
</table>

Reasonable adjustments for people with disabilities must be made to assessment processes where required. This could include access to modified equipment and other physical resources, and the provision of appropriate assessment support.
### Method of assessment

<table>
<thead>
<tr>
<th>Assessment methods must:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• satisfy the endorsed Assessment Guidelines of the Construction, Plumbing and Services Training Package</td>
</tr>
<tr>
<td>• include direct observation of tasks in real or simulated work conditions, with questioning to confirm the ability to consistently identify and correctly interpret the essential underpinning knowledge required for practical application</td>
</tr>
<tr>
<td>• reinforce the integration of employability skills with workplace tasks and job roles</td>
</tr>
<tr>
<td>• confirm that competency is verified and able to be transferred to other circumstances and environments.</td>
</tr>
</tbody>
</table>

Validity and sufficiency of evidence requires that:

- competency will need to be demonstrated over a period of time reflecting the scope of the role and the practical requirements of the workplace
- where the assessment is part of a structured learning experience the evidence collected must relate to a number of performances assessed at different points in time and separated by further learning and practice, with a decision on competency only taken at the point when the assessor has complete confidence in the person’s demonstrated ability and applied knowledge
- all assessment that is part of a structured learning experience must include a combination of direct, indirect and supplementary evidence.

Assessment processes and techniques should as far as is practical take into account the language, literacy and numeracy capacity of the candidate in relation to the competency being assessed.

Supplementary evidence of competency may be obtained from relevant authenticated documentation from third parties, such as existing supervisors, team leaders or specialist training staff.
Range statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

| Information includes: | • diagrams or sketches  
| | • instructions issued by authorised organisational or external personnel  
| | • manufacturer specifications and instructions  
| | • maps  
| | • material safety data sheets (MSDS)  
| | • memos  
| | • organisation’s work specifications and requirements  
| | • plans and specifications  
| | • regulatory and legislative requirements  
| | • relevant Australian standards  
| | • safe work procedures or equivalent  
| | • signage  
| | • verbal or written and graphical instructions  
| | • work bulletins  
| | • work schedules. |

| Safety (OHS) is to be in accordance with state or territory legislation and regulations, organisational safety policies and procedures, and project safety plan and may include: | • clothing and equipment  
| | • handling of materials  
| | • hazard control  
| | • hazardous materials and substances  
| | • organisational first aid  
| | • use of firefighting equipment  
| | • use of tools and equipment  
| | • workplace environment and safety. |

| Equipment includes: | • calculators and laser equipment  
| | • rulers  
| | • tape measures  
| | • trundle wheels. |
### Measurements

are to:

- be in metric scale
- cover all necessary calculations.

### Areas and volumes

include:

- calculating regular and irregular shapes, such as rectangles, squares, circles, triangles, trapeziums, cubes, cones, pyramids and cylinders that represent calculations taken in a construction environment.

### Calculation factors:

- include length, area, weight, height, width, depth, volume, mass, scales, ratios, perimeters, quantities, numbers, grade, percentages, addition, subtraction, multiplication and division
- are to be performed manually and with the aid of a calculator.

### Material quantities

are to be:

- calculated in either packed, bulk, loose or compacted states
- converted to volumes in the other states.
Annex B – Assessments

The assessments suggested here for this unit are designed to assess your competency in the elements as listed in the unit details at Annex A to this guide. There are three components to the assessment.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment 1 – Calculations and units</strong></td>
<td>1, 2</td>
</tr>
<tr>
<td>This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment 2 – Calculating perimeter, area and volume</strong></td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment 3 – Calculating and estimating material quantities</strong></td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Your lecturer may provide you with alternative assessments.

**Individual learning and assessment needs**

Learners have different learning styles and needs. Please let your lecturer know if there is anything that may have an effect on your learning.

**Results and appeals**

There is a process to be followed should you wish to appeal the result of your assessment. Please ask your lecturer for more information about this.
Carry out measurements and calculations
Assessment 1 – Calculations and units

This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.

Read each question carefully.

Materials and equipment

To attempt this assessment you will need:

• the assessment paper
• this guide
• a calculator
• a pen or pencil and an eraser.
Carry out measurements and calculations

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Carry out measurements and calculations

Assessment 1 – Calculations and units

Name ________________________________ Date _____________

I have received feedback on this assessment.

Signature ______________________________ Date _____________

Assessor’s initials
Carry out measurements and calculations
Assessment 1 – Calculations and units

Use a calculator to find the answers to questions 1–4. Show your working out if you wish.

1. Carry out the following additions.
   a) $20 + 316 + 4300 = \underline{}$
   b) $5.592 + 12.476 + 0.500 = \underline{}$
   c) $0.750 + 8.7744 + 2.345 = \underline{}$

2. Carry out the following subtractions.
   a) $653 – 179 = \underline{}$
   b) $6.76 – 1.610 = \underline{}$
   c) $2969.445 – 845.708 = \underline{}$

3. Carry out the following multiplications.
   a) $27.76 \times 35 = \underline{}$
   b) $18.017 \times 3.58 = \underline{}$
   c) $0.976 \times 0.675 = \underline{}$

4. Carry out the following divisions.
   a) $1565 \div 25 = \underline{}$
   b) $85.325 \div 27.5 = \underline{}$
   c) $750 \div 0.75 = \underline{}$

Write the answers to the following questions in the spaces provided.

5. a) The two metric units of length used in the building industry are: ____________________ and ____________________.
   b) The metric unit of area used in the building industry is ____________________.
   c) The metric unit of volume used in the building industry is ____________________.

6. Convert the following from metres to millimetres.

<table>
<thead>
<tr>
<th>Metres</th>
<th>Millimetres</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) $15.662$</td>
<td>= \underline{}</td>
</tr>
<tr>
<td>b) $0.195$</td>
<td>= \underline{}</td>
</tr>
</tbody>
</table>
7. Convert the following from millimetres to metres

<table>
<thead>
<tr>
<th>Millimetres</th>
<th>Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 830</td>
<td></td>
</tr>
<tr>
<td>b) 5150</td>
<td></td>
</tr>
</tbody>
</table>

8. When dimensions in millimetres are to be used for either area or volume calculations, what should be done to the dimensions before making the calculation?

9. Write the formula for each of the following.

- Perimeter of a rectangle: \( P = \)
- Area of a rectangle: \( A = \)
- Area of a circle: \( A = \)
- Volume of a rectangular prism: \( V = \)
- Area of a triangle: \( A = \)

End of Assessment 1
Assessment 2 – Calculating perimeter, area and volume

This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.

Read each question carefully.

Materials and equipment

To attempt this assessment you will need:

- the assessment paper
- this guide
- a calculator
- a pen or pencil and an eraser.
Carry out measurements and calculations

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CPCCCM1015A

Carry out measurements and calculations

Assessment 2 – Calculating perimeter, area and volume

Name ___________________________ Date __________

I have received feedback on this assessment.

Signature ___________________________ Date __________

Assessor’s initials

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BC2120 Annex B
Carry out measurements and calculations

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Assessment 2 – Calculating perimeter, area and volume

1. Calculate the perimeters of the following two shapes.
   a) [Diagram of a shape with dimensions 4.950, 8.150, 2.470, and 9.450]
      
      Formula = ________________
      ________________________
      ________________________
      ________________________
      ________________________
      Answer = ________________

   b) [Diagram of a circle with diameter 7.800]

      Formula = ________________
      ________________________
      ________________________
      ________________________
      ________________________
      Answer = ________________
2. Calculate the area of this shape.

![Shape Diagram]

Formula = 

Answer = 

3. Calculate the area of this triangle.

![Triangle Diagram]

Formula = 

Answer =
4. The measurements of this concrete cube are 2.4 H × 2.4 W × 2.4 L.
Calculate the volume in cubic metres.

Formula = .................. 

Answer = ..................

5. Calculate the net surface area of brick paving (the shaded area) in this sketch of a courtyard.

Formula = .................. 

Answer = ..................
Carry out measurements and calculations

CPCCCM1015A
Assessment 3 – Calculating and estimating material quantities

This is an open-book assessment. You may seek guidance from your lecturer, and you may refer to this guide if you wish. You may use a calculator.

Read each question carefully.

Materials and equipment

To attempt this assessment you will need:

• the assessment paper
• this guide
• the Hopscotch Homes plans (provided at Annex C to this guide)
• a calculator
• a pen or pencil and an eraser
• a scale rule.
Carry out measurements and calculations
CPCCCM1015A

Carry out measurements and calculations

Assessment 3 – Calculating and estimating material quantities

Name ____________________________ Date ____________

I have received feedback on this assessment.

Signature __________________________ Date ____________

Assessor’s initials
Carry out measurements and calculations

CPCCM1015A
Assessment 3 – Calculating and estimating material quantities

1. Calculate the net surface area of the walls of Bed 2 in this part plan.
   The ceiling height is 2450, the door is 2060 high and the window is 1810 high.

   Formula = 

   Answer =
2. Calculate the volume of concrete required for the porch slab in this part plan.

Formula = 

Answer = 
3. This sketch shows part of a block of land. A fence is to be erected on the two sides shown. Calculate how many fence posts will be required for the job if they are to be placed at a maximum of 2.4 m centres.

Formula = 

Answer = 
4. View the Hopscotch Homes floor plan. Use your scale rule to measure the following. Give your answers in metres (m).
   a) Internal perimeter of Bed 2, excluding the walk-in robe (WIR).

   

   b) External perimeter of the building including the garage.

   

   c) Length of the kitchen benchtops.

   

   d) Perimeter of the alfresco cover.

   

   e) Length of the steel beam (200 UB) that spans the family and meal rooms.
5. Point A has a height of 3 m above natural ground level, and point B has a height of 1 m above ground level. These two points are 10 m distance apart.

a) What is the height difference between the two points?

b) With the aid of a sketch, describe how the ground slopes upwards or downwards from point A to point B.

c) What is the gradient from A to B, stated as a ratio?
6. Consider the safety policies for a building site. List four safety requirements that should be considered when doing measurements.

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

7. Consider the safety policies for workers on a building site. List four safety requirements on a typical building site.

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

8. Using the floor plan provided here, drawn at a scale of 1:100, carry out calculations and estimates detailed in a), b), c) and d) on the next page for the living room only.

   Reproduced or adapted with the permission of WA Country Builders.
a) How many bricks will be needed for the largest external wall? The face size of the bricks for this home is 76 × 230.

b) What total length of timber skirting will it take to do the perimeter of the room?

c) If the client goes with the 300 × 300 tiles they’ve been looking at, how many tiles will it take to do the floor?

d) How much concrete will it take to pour the slab to a thickness of 160 mm?

e) What equipment would you use to measure up then calculate quantities for each of the following?

   Bricks
   Skirting
   Tiles
   Slab
9. What would be the best way to look after your measuring equipment? Circle the correct answer.
   a) Keep it all together in a bag in the back of the ute.
   b) Keep each piece of equipment in its own bag or box.
   c) Wear it all in a tool belt.
   d) Throw it in the back of the ute and keep the lid closed.

10. What would be your top three tips to make sure you could work effectively and
    communicate with other tradespeople when you’re carrying out measurements and
    calculations?

    ____________________________________________
    ____________________________________________
    ____________________________________________
    ____________________________________________
    ____________________________________________

11. When doing estimates, what document(s) tell you the specific materials that are
    going to be used (eg tiles, bricks) and any quality requirements?

    ____________________________________________
    ____________________________________________
    ____________________________________________

12. What communication technology could you use if you had to send another
    tradesperson information about quantities of materials required for a job?

    ____________________________________________
    ____________________________________________

End of Assessment 3
Annex C – Plans
Carry out measurements and calculations
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Carry out measurements and calculations
Carry out measurements and calculations

CPCCM1015A
Floor Areas

<table>
<thead>
<tr>
<th>GARAGE</th>
<th>HOUSE</th>
<th>PORCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (m²)</td>
<td>23.88</td>
<td>150.04</td>
</tr>
<tr>
<td>178.42 m²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Perimeter (m)

<table>
<thead>
<tr>
<th>GARAGE</th>
<th>HOUSE</th>
<th>PORCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.92</td>
<td>59.10</td>
<td>8.60</td>
</tr>
<tr>
<td>91.62 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Plans

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CPCCM1015A
CARRY OUT MEASUREMENTS AND CALCULATIONS
CERTIFICATE II IN BUILDING AND CONSTRUCTION
(PATHWAY – TRADES)
CPCCCM1015A

LEARNER’S GUIDE

DESCRIPTION
This learner’s guide will help you to carry out measurements and perform simple calculations to determine task and material requirements for a job in a construction work environment. It contains a mix of content and hands-on activities that support the unit CPCCCM1015A Carry out measurements and calculations from the Certificate II in Building and Construction (Pathway – Trades). The course, and this guide, focuses on the skills and knowledge required to get your career started as a tradesperson in the building and construction industry.

The topics covered in this guide include:
• measuring equipment and tools, and how they are used
• measurement methods used in the construction industry
• calculating areas and volumes
• calculating quantities of materials for construction jobs.

You will also learn about how to find the information you need to take measurements and perform calculations from drawings and plans. Suggested assessment activities are included.

EDITION
Edition 1, 2014

TRAINING PACKAGE
CPC08 Construction, Plumbing and Services Training Package

COURSE / QUALIFICATION
Certificate II in Building and Construction (Pathway – Trades)

UNIT OF COMPETENCY
CPCCCM1015A Carry out measurements and calculations

RELATED PRODUCTS
This resource is one in a series that covers all six core units for the Certificate II in Building and Construction (Pathway – Trades) qualification. Please refer to the WestOne product catalogue for more information.

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