CURRICULUM RESOURCE

Masonry Math 1: Measurements and Calculations

OALCF ALIGNMENT

Competency	Task Group	Level
Competency A - Find and Use Information	**A1. Read continuous text**	**2**
Competency A -Find and Use Information	**A2. Interpret documents**	**2**
Competency B - Communicate Ideas and Information	**B3. Complete and create documents**	**2**
Competency C - Understand and Use Numbers	**C3. Use measures**	**2**

Goal Paths (check all that apply)

☐ Employment
☒ Apprenticeship
☐ Secondary School Credit
☐ Postsecondary
☐ Independence

Embedded Skills for Success (check all that apply)

☐ Adaptability
☐ Collaboration
☐ Communication
☐ Creativity and innovation
☐ Digital
☒ Numeracy
☒ Problem Solving
☒ Reading
☒ Writing

NOTES: This resource is one in a series of four focused on the masonry trade. It introduces the International System of Units (SI) and how to convert one unit of measurement to another. It also outlines the dimensions of height, width, and length; the calculations for finding perimeter and area; and how to determine a 90-degree angle (based on the Pythagorean theorem). Learners should be familiar with decimal place values before using this resource.

ACKNOWLEDGEMENTS

Project Host
Community Literacy of Ontario

Research & Writing
Summer Burton

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communityliteracyofontario.ca
(705) 733-2312
info@communityliteracyofontario.ca
@CommunityLiteracyOntario
@love4literacy
@love4literacy

Units of Measurement

"The International System of Units, or SI, is the simplified and internationally accepted version of the metric system. SI holds many advantages over other systems of measurement. Decimals replace fractions, simple prefixes replace lengthy, hard to read strings of zeros, and the need for conversion factors (that is, numbers used to multiply or divide other numbers when converting from one measuring system to another) is entirely eliminated.

The "Textbook of Canadian Masonry" (second edition)
by the Canadian Masonry Contractor's Association.

Canada adopted the **International System of Units (SI)** in 1971. It is used in Canadian manufacturing, architecture, engineering, and masonry construction.

SI has two parts: **units** and **prefixes**. (Remember that a prefix is always at the beginning of a word.)

SI units are measurements of length, area, volume, mass, or temperature. In masonry, they commonly include:	**SI prefixes** are symbols that represent multiples of ten. In masonry, they commonly include:
• Metre • Gram • Pascal • Degrees Celsius	• Kilo (one thousand units) • Centi (a one hundredth of a unit) • Milli (a one thousandth of a unit)

When you put SI units and prefixes together, you can accurately describe a measurement without having to use a lot of zeros for large measurements or decimal points for small measurements. We will take a look at some examples on the next page.

Scenario 1: A mason is measuring the distance between their home and a job site.

The International System of Units (SI) unit they will use is **metres**. The SI prefix they will use is **kilo**, which is one thousand units. That means they know the distance they are measuring is much longer than a metre. Instead of measuring in metres, they will measure how many 1,000-metre units their home is from the job site.

If their home is 45,000 metres from the job site, it is 45 kilometres away. These numbers are the same, but the word “kilo” replaces the three zeros.

Scenario 2: A mason is measuring the length of a concrete block so they can figure out how many they need for a job.

The SI unit they will use is **metres**. The SI prefix they will use is **centi**, which is a one hundredth of a unit. That means they recognize the length they are measuring is smaller than a metre. Instead of measuring in full metres, they will measure how many one-hundredths of a metre the length of the concrete block is.

If the concrete block is 0.39 metres long, it is 39 centimetres long. These numbers are the same, but the word “centi” lets the mason record a whole number instead of using a decimal. The mason could also use “milli,” which represents a one thousandth of a unit. The same concrete block is 390 millimetres long.

Scenario 3: A mason is measuring the weight (mass) of the bags sand they will use when mixing mortar.

The SI unit they will use is **grams**. The SI prefix they will use is **kilo**, which is one thousand units. That means they know each bag of sand weighs much more than a gram. Instead of measuring in grams, they will measure how many 1,000-gram units each bag of sand weighs.

If each bag of sand weighs 20,000 grams, they weigh 20 kilograms. These numbers are the same, but just like in our first example, the word “kilo” replaces the three zeros.

Note: Although we often use the words “weight” and “mass” to mean the same thing, mass is the correct word for describing how heavy an object is.

There are more International System of Units (SI) prefixes than just milli, centi, and kilo. Take a moment to read the chart below to learn about SI prefixes and what they represent.

Prefix Name	Prefix Symbol	Number Equivalent
Mega	M	One million units
Kilo	k	One thousand units
Hecto	h	One hundred units
Deca	da	Ten units
Everything above this line represents a measurement of more than a single unit. Everything below this line represents a smaller part of a unit.		
Deci	d	A tenth of a unit
Centi	c	A hundredth of a unit
Milli	m	A thousandth of a unit
Micro	μ	A millionth of a unit

SI Prefix symbols are helpful because with them you can identify what prefix you are using without writing out the whole word. SI Units also have symbols. They are generally the first letter of the unit of measurement. Using this system, grams would be "g", and metres would be "m". This means:

- A tenth of a metre can be written as dm instead of decimetre.
- One hundred grams can be written as hg instead of hectogram.

Activity: Use the information above to answer the following questions.

How would you write the symbol for milligram? _____

What is the prefix name and symbol for 10 units? Name: _____ Symbol: _____

Two of these prefixes use the letter "m" as a symbol. The prefix with the upper-case symbol is: _____ The prefix with the lower-case symbol is: _____

What is the smallest prefix on the chart called? _____

What does it represent? _____

Converting Measurements

Because masons use the International System of Units (SI), converting units of measurement from one prefix to another is easy. Simply move the decimal place!

This chart will show you how to do it.

Prefix Name	Mega	Kilo	Hecto	Deca	This space = one unit	Deci	Centi	Milli	Micro
Prefix Symbol	M	k	h	da		d	c	m	μ
Decimal Place	Move three decimal places	Move one decimal place	Move one decimal place	Move one decimal place	Move one decimal place	Move one decimal place	Move one decimal place	Move one decimal place	Move three decimal places

The decimal place always moves in the same direction as the changing prefix. If a mason was asked to convert something measured in kilometres into hectometres, they could move the decimal place one number to the right (because hecto is one spot to the right of kilo on this chart).

Note that when converting from kilo to mega, or milli to micro, the decimal will move over **three** places.

Tip: if a unit of measurement doesn't have a decimal in it, picture a decimal followed by a zero right after the number:

32 cm is the same as 32.0 cm 427 kg is the same as 427.0 kg

If the mason was asked to convert 41 kilograms into hectograms, they would add the decimal and the zero at the end of 41. Their first number would be 41.0 kg.

41.0 kg

The mason would then move the decimal place one number to the right.

410 hg

After moving the decimal place, the mason would update the SI symbol.

"One of the most versatile features of SI is the ability to convert measurements from one prefix to another simply by moving the decimal place. Converting a measurement to a different prefix can make a number more readable and easier to work with (for example 1 km instead of 1 000 000 mm)."

The "Textbook of Canadian Masonry" (second edition) by the Canadian Masonry Contractor's Association.

Activity: Use what you learned to convert the following units of measurement.

Convert 7.5 hectograms (hg) to decagrams (dag): _____

Convert 74.32 decimetres (dm) to centimetres (cm): _____

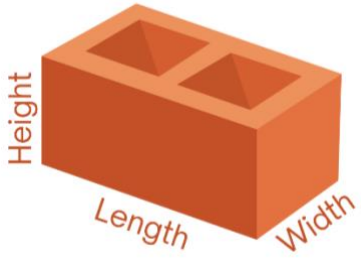
Convert 65 922 metres (m) to kilometres (km): _____

Convert 14 milligrams (mg) to micrograms (µ): _____

The most common prefixes used in everyday measurements (including in the masonry trade) are kilo, centi, and milli. But it's still good to be familiar with some of the less common prefixes used in SI measurements, as in some of the examples above.

Dimensions

Masons work in three dimensions: width, height, and length. These dimensions are important because they help masons decide how many masonry units (e.g., bricks, concrete blocks, or stones) they need to build walls in the size the job requires.



The **width** is the distance from the front to the back of the brick or stone.
The **height** is how tall the brick or stone is.
The **length** is how wide the brick or stone is.

For example, a **Canadian Standard Residential (CSR)** brick measures 90 millimetres wide, 70 millimetres high, and 230 millimetres long. This is one of the most commonly used bricks in Canada. The chart below shows the dimensions of other commonly used bricks.

Brick Name	Width, Height and Length (in mm)	Brick Name	Width, Height and Length (in mm)
CSR	90 wide, 70 high, and 230 long	**Jumbo**	90 wide, 90 high, and 290 long
Giant	90 wide, 90 high, and 390 long	**Modular**	90 wide, 57 high, and 190 long
King	80 wide, 70 high, and 240 long	**Norman**	90 wide, 57 high, and 290 long
Max	90 wide, 79 high, and 257 long	**Titan**	90 wide, 63 high, and 190 long

Activity: Use the information in the chart to answer the following questions.

1. Circle which brick is **wider**: The King The CSR

2. How many millimetres wider is it? _____

3. Circle which brick is **higher**: The Titan The Modular

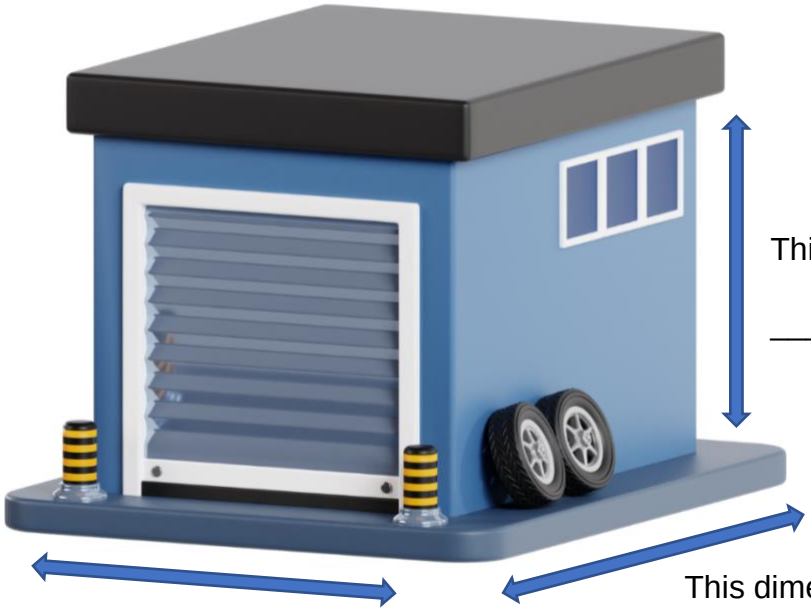
4. How many millimetres higher is it? _____

5. Circle which brick is **longer**: The Norman The Giant

6. How many millimetres longer is it? _____

Masons also need to recognize the dimensions (measurements) of the project they are meant to complete. For example, they may need to build walls for a garage that is 6.7 metres in width (how far back the garage goes), 2.4 metres high, and 3.7 metres long (across the front of the garage).

Activity: Label the picture of the garage below with which dimension is its width, height, and length.



This dimension is the:

_____

This dimension is the:

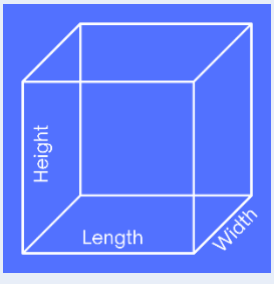
_____

This dimension is the:

_____

"The ability to read and interpret dimensions is important whenever any construction is to be done, including masonry work. Dimensions provide the information on the size and location of different parts of the building."

The "Textbook of Canadian Masonry" (second edition) by the Canadian Masonry Contractor's Association.



Perimeter and Area

Once a mason knows the dimensions of their masonry unit or project, they can begin calculating:

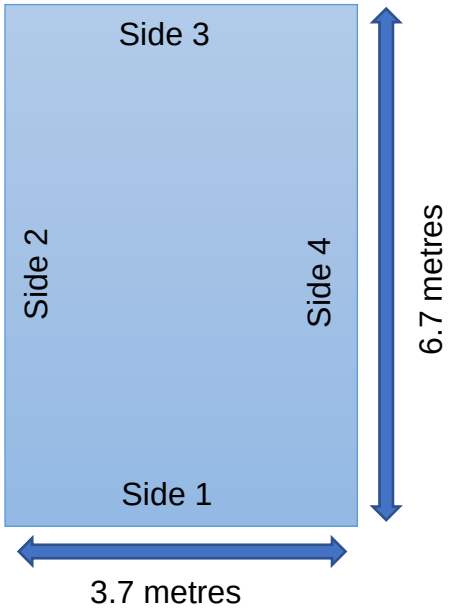
- perimeter (the distance around the outside of a shape)
- area (the amount of space inside a shape)

Perimeter

Masons use perimeter to learn about the "footprint" of a structure's foundation and its external walls. Let's start by calculating the **perimeter** of the garage on the last page.

Picture yourself looking down at the garage from above. From above, the garage is a **rectangle**. It has four sides. Two of the sides are the same, measuring 6.7 metres each, and the other two sides are also the same, measuring 3.7 metres each.

To find out the perimeter, add up all four sides of the garage. The equation looks like this:

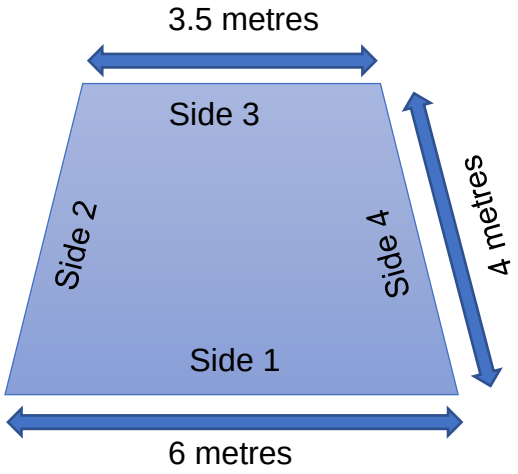


3.7 metres	**+**	**6.7 metres**	**+**	**3.7 metres**	**+**	**6.7 metres**	**=**	**20.8 metres**
Side 1		Side 2		Side 3		Side 4		Perimeter

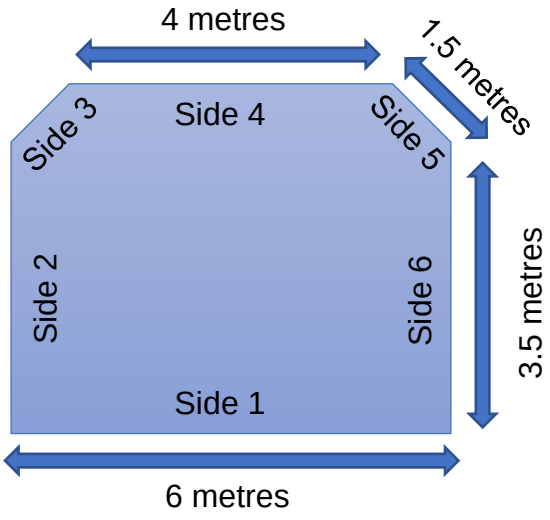
The structure a mason is going to work on may not be rectangular. It may be square (with all four sides having the same measurement), or it may have more than four sides, all with different measurements. On the next page, we will look at some examples.

This structure is narrow at one end, and wide at the other. There are still four sides, but only two are the same. The shape of this structure is called a **trapezoid**.

To figure out the perimeter of this structure, add up all four sides just as we did for the rectangular garage. The equation looks like this:



6 metres	+	**4 metres**	+	**3.5 metres**	+	**4 metres**	=	**17.5 metres**
Side 1		Side 2		Side 3		Side 4		Perimeter



This structure is a **rectangle**, but it has corners that are cut at an angle. Now there are six sides to measure. Side 2 and side 6 are the same, and sides 3 and 5 are the same.

To figure out the perimeter of this structure, add up all six sides. The equation looks like this:

6 metres	+	**3.5 metres**	+	**1.5 metres**	+	**4 metres**	+	**1.5 metres**	+	**3.5 metres**	=	**20 metres**
Side 1		Side 2		Side 3		Side 4		Side 5		Side 6		Perimeter

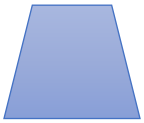
Activity: Calculate the perimeter of the following structures. You can use a calculator if you wish.

Structure 1: A **square** building. Each of the four sides is 18 metres.

_____	+	_____	+	_____	+	_____	=	_____
Side 1		Side 2		Side 3		Side 4		What is the Perimeter?

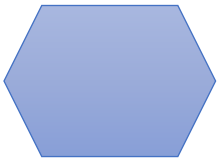
Structure 2: A **rectangular** building. Two of the sides are 6.5 metres, and the other two are 8 metres.

_____	+	_____	+	_____	+	_____	=	_____
Side 1		Side 2		Side 3		Side 4		What is the Perimeter?



Structure 3: A **trapezoid**-shaped building. Two of the sides are 11 metres, one side is 7 metres, and the other side is 3.5 metres.

_____	+	_____	+	_____	+	_____	=	_____
Side 1		Side 2		Side 3		Side 4		What is the Perimeter?



Structure 4: A six-sided building. It has two sides that each measure 28 metres, and four sides that each measure 10 metres. The shape of this structure is called an irregular **hexagon**.

_____	+	_____	+	_____	+	_____	+	_____	+	_____	=	_____
Side 1		Side 2		Side 3		Side 4		Side 5		Side 6		What is the Perimeter?

Area

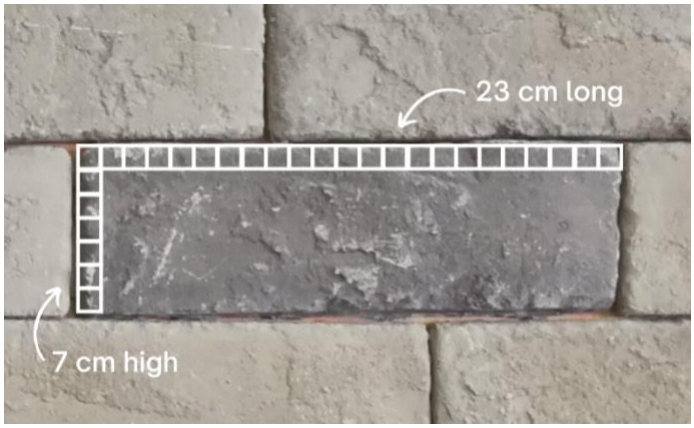
By looking at the height and length of the wall they need to build, a mason can also figure out its **area**. Masons use this information when they decide how many masonry units they will need to build the wall.

In masonry, area is measured in square units. Here are some examples:

- Square metres, which is written as m^2
- Square centimetres, which is written as cm^2
- Square millimetres, which is written as mm^2

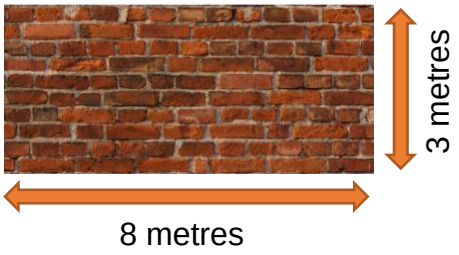
Let's look at an example of a calculation for finding the area of a Canadian Standard Residential (CSR) brick in square centimetres.

The CSR brick is 7 centimetres (cm) high and 23 centimetres (cm) long. Each centimetre of the height and length of the brick is shown in the image below.



To calculate the area of this brick, we will multiply the height of the brick by its width. The result will be the area of the brick in square centimetres (cm^2). Here is what that equation looks like:

23 cm	**X**	**7 cm**	**=**	**161 cm^2**
Length of the brick		Height of the brick		Area of the brick



To calculate the **area** of a wall, we will multiply how long the wall needs to be by how high the wall needs to be. For example, if a wall needs to be 8 metres (m) long and 3 metres (m) tall, the equation looks like this:

8m	**X**	**3m**	**=**	**24 m^2**
Length of the wall		Height of the wall		Area of the wall

Calculating the area of a wall is simple when the wall is a solid square or rectangular. If a mason is working on a structure with windows and doors, they need to think about those items when figuring out the area of the wall.

To do this, the mason would first find the overall area of the wall by multiplying its height and length just as we did above. Using the wall dimensions above, the equation looks like this:

8m	**X**	**3m**	**=**	**24 m^2**
Length of the wall		Height of the wall		Overall area of the wall

Then, they would find the area of the door by multiplying its height and length. For a door that is 0.9 metres (m) long by 2 metres (m) high, the equation looks like this:

0.9 m	**x**	**2 m**	**=**	**1.8 m^2**
Length of the door		Height of the door		Area of the door

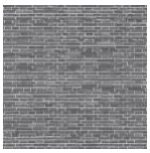
The mason would then find the area of the window by multiplying its height and length. For a window that is 0.6 metres (m) long by 0.9 metres (m) high, the equation looks like this:

0.6 m	**x**	**0.9 m**	**=**	**0.54 m²**
Length of the window		Height of the window		Area of the window

Once the mason knows the area of each of these elements, they can calculate the actual area of the wall. This is done by taking away the area of the window and the door from the first calculation for the overall area of the wall. The equation looks like this:

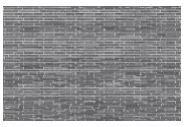
24 m	**-**	**1.8 m**	**-**	**0.54 m**	**=**	**21.66 m²**
Overall area of the wall		Area of the door		Area of the window		Actual area of the wall

Activity: Calculate the area of the following walls. You can use a calculator if you wish.



Wall 1: A **square** wall that is 3 metres (m) long and 3 metres (m) high.

_____	**x**	_____	**=**	_____
What is the length of the wall?		What is the height of the wall?		What is the area of the wall?



Wall 2: A **rectangular** wall. It is 6.5 metres (m) long and 2.5 metres (m) high.

_____	**x**	_____	**=**	_____
What is the length of the wall?		What is the height of the wall?		What is the area of the wall?

Wall 3: A **square** wall that is 3.5 metres (m) wide and 3.5 metres (m) high. In that wall is a **door** measuring 1 metre (m) wide and 2 metres (m) high. There is also a **window** measuring 0.75 metres (m) wide and 1 metre (m) high.

First, calculate the overall area of the wall.

_____	x	_____	=	_____
What is the length of the wall?		What is the height of the wall?		What is the overall area of the wall?

Then find the area of the 1 metre (m) long and 2 metre (m) high door.

_____	x	_____	=	_____
What is the length of the door?		What is the height of the door?		What is the area of the door?

Now find the area of the 0.75 metre (m) long and 1 metre (m) high window.

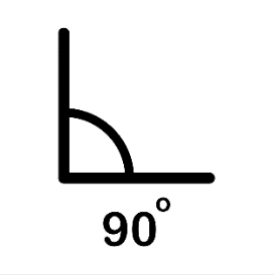
_____	x	_____	=	_____
What is the length of the window?		What is the height of the window?		What is the area of the window?

Finally, calculate the actual area of the wall.

_____	-	_____	-	_____	=	_____
What is the overall area of the wall?		What is the area of the door?		What is the area of the window?		What is the actual area of the wall?

Right Angles

One of a masons' daily routines is to measure right angles. A right angle is 90 degrees (also written as 90º) and it refers to the angle between two walls that come together to form a corner.



"Whether working with paint lines, chalk lines, a poured foundation or dry-laid units, it is important to check that each corner of a structure is square (that is, that it follows a 90º angle) before beginning to lay the units."

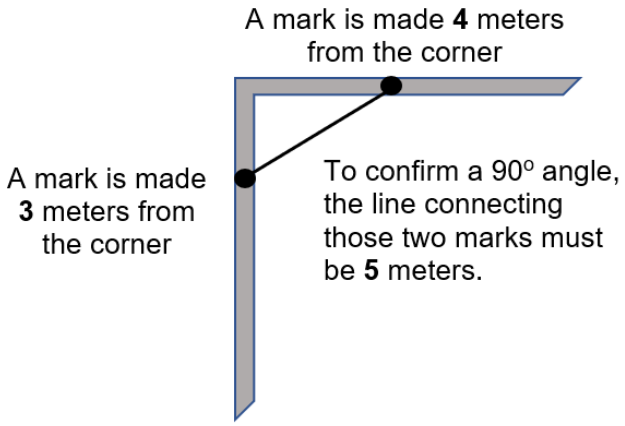
The "Textbook of Canadian Masonry" (second edition) by the Canadian Masonry Contractor's Association.

A simple and reliable method for checking a 90-degree angle is called the **3-4-5 method**. Here is how a mason would use this method.

First, they would measure **3** metres along one side of a corner and make a mark.

Then, they would measure **4** metres along the other side of the corner and make a mark.

Finally, the mason would measure the diagonal distance between the two marks they made. It should measure exactly **5** metres. If it doesn't, the corner is not 90-degrees.



The **3-4-5 method** can be used with any unit of measurement. The mason could measure three, four, and five millimetres, centimetres, inches, or feet. Remember, the units of measurement most often used in Canadian masonry is International System of Units (SI), so you will use metres. This simple method is based on something called the **Pythagorean theorem**. (The Pythagorean theorem is named after the person who discovered it hundreds of years ago. His name was Pythagorus.) As a masonry apprentice, you would use the Pythagorean theorem during in-class lessons, and on the job site.

Activity: Answer the following questions about right angles.

How is a right angle written in degrees? _____

Can the 3-4-5 method be used with any unit of measurement? ☐ Yes ☐ No

What is the name of the units of measurement most often used in Canadian masonry?

_____

The 3-4-5 method has another name based on the person who discovered it. What is the other name?

_____

Conclusion

In this resource, you learned about the many ways that masons use math on the job.

Check off the information you learned about below.

- ☐ The International System of Units (SI)
- ☐ Different SI units and prefixes
- ☐ Converting from one SI prefix to another
- ☐ The dimensions of height, width, and length
- ☐ Calculating perimeter and area
- ☐ The 3-4-5 method of finding a right angle

Tip: If you didn't fill in one of the checkboxes, go back to that section and read it again. Ask a classmate, teacher, or tutor to share what they know about masonry math.

Next Steps

For more information about becoming a brick and stone mason in Ontario, you can complete the other resources in this series:

- Professionalism in Masonry
- Tools of the Masonry Trade
- Masonry Math 2: The Next Step in Numbers

You can also visit this helpful website:

- The Canadian Masonry Contractors Association: https://canadianmasonrycontractors.com/