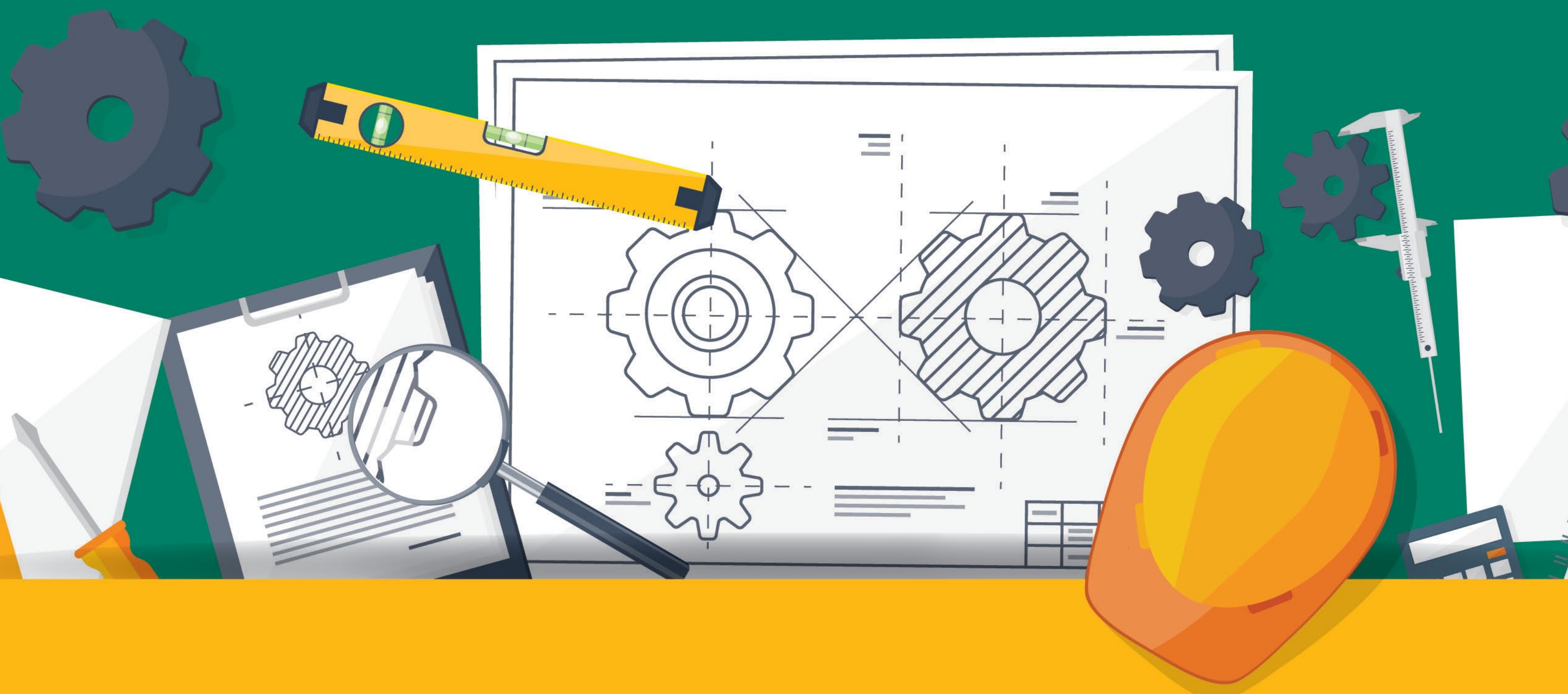


CONSTRUCTION

ESSENTIAL MATH SKILLS FOR THE APPRENTICE

Dual Credit
School College Work Initiative

Student Handbook

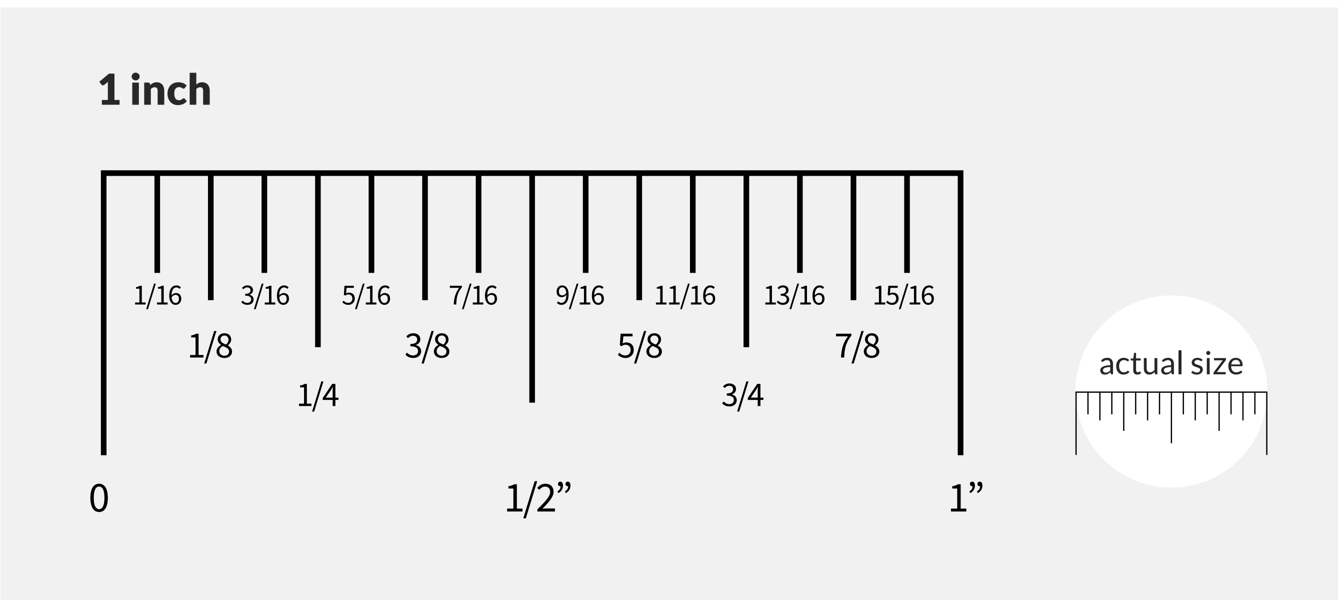
Measurement

In all trades the most commonly used tool is the tape measure.

Understanding units of measurement is vital to a successful career in the trades. This skill-set will ensure that a tradesperson will manage materials efficiently, increase the accuracy of the work and avoid costly mistakes. Remember to **measure twice, and cut once**.

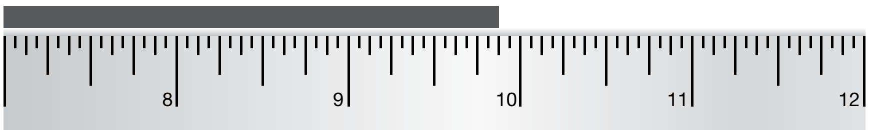
This lesson will focus on the imperial tape measure as it is most commonly used in general carpentry. In carpentry, generally the smallest measurements are increments of $\frac{1}{16}$ of an inch. As seen in the illustration below 1 inch or 1" is broken into 16 equal segments. A further look at the illustration will reveal that the segment values are not always expressed in 16^{ths}s. Fractions will be reduced to the lowest common denominator (LCD).
For example: $\frac{2}{16}$" = $\frac{1}{8}$", $\frac{4}{16}$"= $\frac{1}{4}$", $\frac{6}{16}$" = $\frac{3}{8}$" and so on.

These fractions of an inch make up every inch, there are 12 inches in 1 foot or 1'.
For example, if an object is measured by hooking the tape measure on to one end and is extended past the end of the object and is found to be 27 $\frac{12}{16}$ inches (") the measurement can also be expressed as 2 foot 3 and $\frac{3}{4}$ of an inch, or 2' – 3 $\frac{3}{4}$".

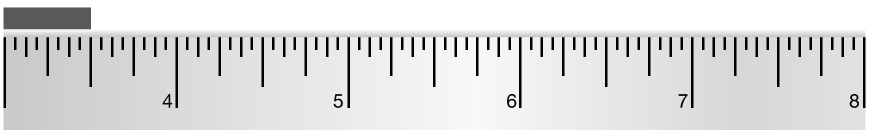


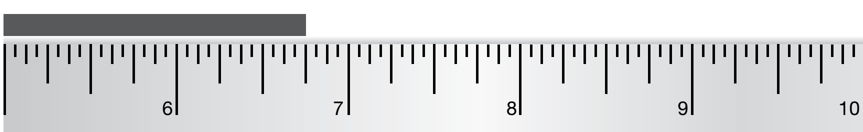
How many inches?

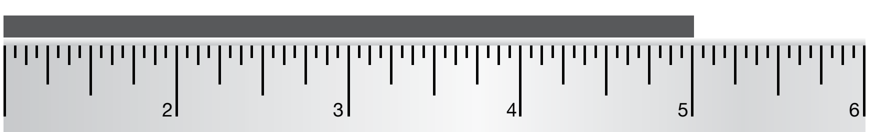
10 1⁄16”



9 7⁄8”







Fractions or Mixed Numbers to Decimals Conversions

In the trades you must be able to convert linear measurements from feet, inches and fractions of an inch (known as a mixed number) and vice versa. It is often necessary to convert mixed numbers to decimals to input them into calculations then return the solution to a mixed number for measurement purposes.

In order to convert a fraction to a decimal, divide the numerator by the denominator.

Example 1: Convert ⅝” to decimal inches
5 ÷ 8 = 0.625”
Therefore ⅝” is equal to 0.625 of one inch.

Example 2: 15⁄16” = 0.9375”

Example 3: 7⁄16” = 0.437”

To convert a mixed number (inches and fractions of an inch) into a decimal, keep the whole number and convert the fraction into a decimal.

Example 1: Convert 3 ⅞” to decimal inches
3 is the number of whole inches, write the 3 to the left of the decimal (3.)

Then divide the numerator of the fraction be the denominator
7 ÷ 8 = .875”

Therefore the answer is 3.875”

Example 2: 4 9⁄16” = 4.5625”

Example 3: 7 1⁄16” = 7.0625”

Converting Mixed Numbers (Feet, Inches and Fractions of an Inch) **into Decimal Feet**

The number of whole feet is kept as the number to the left of the decimal, the inches and fraction must be first converted to decimal inches as in the previous example.

Then the decimal inches needs to be converted into decimal feet.

Divide the decimal inches by 12 (the number of inches in a foot), this is then added to the number of whole feet.

Example 1 : Convert 9’ – 4 ⅜” to decimal feet
3 ÷ 8 = .375”

Add the whole number of inches
4 + 0.375 = 4.375”

Divide this by 12 to convert to decimal feet
4.375 ÷ 12 = 0.3645833333’

Round to 4 decimal places
0.3646’

Then add the number of whole feet to the decimal
9 + 0.3646 = 9.3646’

Therefore 9’ – 4 ⅜” is written as 9.3646’

Example 2: 17 ⅝” = 17.625” ÷ 12 = 1.4688’

Example 3: 148 ⅛” = 148.125” ÷ 12 = 12.3438’

Converting Decimals into Mixed Fractions (Feet, Inches and Fractions of an Inch)

The number of feet are removed from the decimal and written as whole feet. The decimal feet is then converted into decimal inches, multiply by 12 the number of inches in a foot. Any whole inches are removed from the decimal and recorded as the number of inches.

The decimal is then multiplied by 16 to express the fraction of an inch to the nearest 16th of an inch.

Once the solution to a problem has been found, convert the decimal feet or inches back to a mixed fraction to be used as a measurement on a tape measure.

Example 1: Convert 5.5468’ into a mixed number, expressed in feet inches and fractions of an inch to the nearest 16th.

The 5 is removed from the decimal and written as 5’

0.5468 is multiplied by 12 to convert to decimal inches 0.5468 x 12 = 6.5616”

Remove the 6 whole inches from the decimal and express as 5’ – 6”

Multiply the decimal by 16 to express the decimal to the nearest 16th of an inch

0.5616 x 16 = 8.9856/16th

Round this to the nearest 16th, in this case round up to 9/16”

Therefore 5.5465’ is expressed as 5’ – 6 9/16”

Example 2: 64.9384” ÷ 12 = 5.4115’ - 5’ = 0.4115’ x 12 = 4.9384” x 16 = 15.0144/16th
5’ - 4 15/16”

Example 3: 19.3149” ÷ 12 = 1.6096’ - 1’ = 0.6096’ x 12 = 7.3149” - 7’ = 0.3149” x 16 = 5.0384/16th
1’ - 7 5/16”

Converting Mixed Fractions to Decimals and Decimals to Mixed Fractions

This in-class assignment will be checked and used as a review for the basic carpentry math skills. Solve the following questions.

Convert mixed fractions to decimal feet to 4 decimal places (round appropriately).

1) 11 ¾” = ____________

2) 13’– 6 ½” = ____________

3) 4 $\frac{9}{16}$” = ____________

4) 144 $\frac{11}{16}$” = ____________

5) 28’– 11 $\frac{15}{16}$” = ____________

Convert decimals to mixed numbers expressed in feet inches and a fraction of an inch to the nearest 16th of an inch (reduce if necessary).

6) 12.5’ = ____________

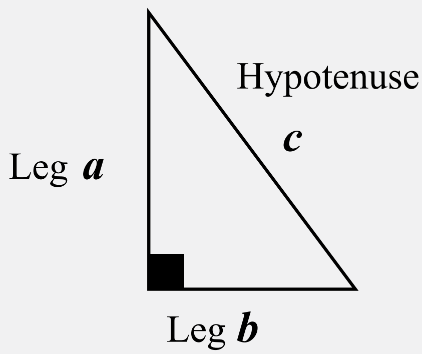
7) 1.875” = ____________

8) 15.989’ = ____________

9) 18.44” = ____________

10) 5.7698’ = ____________

Right Angle Triangle



A right angle triangle consists of two legs (a & b) that meet a 90° angle. The third and longest side of a right angle is opposite to the 90° angle and is known as the **hypotenuse** (c).

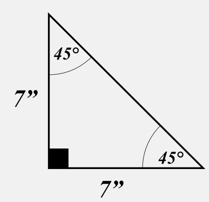
The Pythagorean Theorem equation is $c^2 = a^2 + b^2$

When the length of both leg (a) and leg (b) are known, the Pythagorean Theorem can be used to determine the length of the hypotenuse (c). The Pythagorean Theorem states when the square of leg (a) and leg (b) are added together they are equal to the square of the hypotenuse.

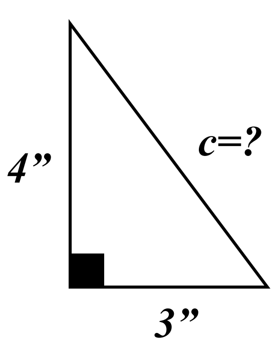
To square a number you multiply it against itself. $3^2 = 3 \times 3 = 9$

Once the dimension of leg (a) and leg (b) have been squared and added together they are equal to the square of the hypotenuse. To find the length of the hypotenuse you must determine the square root of the number. Square root is represented by this symbol √. ($\sqrt{9} = 3$)

The three angles in a triangle always total 180°. If the two legs of a right angle triangle are the same length the two other angles are 45°.

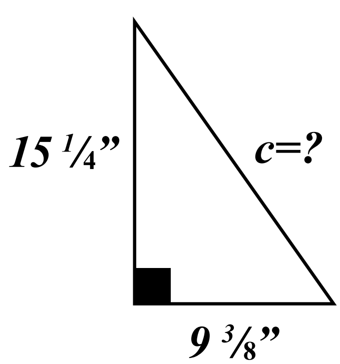


Example 1:



$c^2 = a^2 + b^2$
$c^2 = 4^2 + 3^2$
$c^2 = 16 + 9$
$c^2 = 25$
$c = \sqrt{25}$
$c = 5”$

Example 2:



$c^2 = 15.25^2 + 9.375^2$
$c^2 = 232.5625 + 87.8906$
$c^2 = 320.4531$
$c = \sqrt{320.4531}$
$c = 17.9012”$ or
1’ - 5 ⅞”

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

Answers to be expressed in feet, inches and fractions of an inch.

1) A = 13”
B = 9”
C = X
1’ – 3 13⁄16”

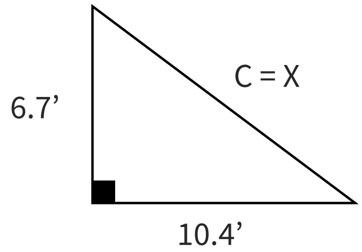
2) A = 57”
B = 23”
C = X
5’ – 1 7⁄16”

3) A = 3’
B = 1.055’
C = X
____

4) A = 9.5’
B = 7.8’
C = X
____

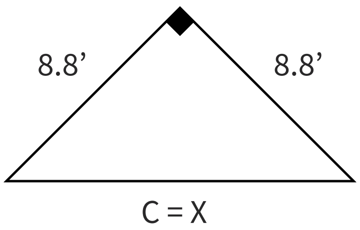
5) A = 8’
B = 3.95’
C = X
____

6)



____

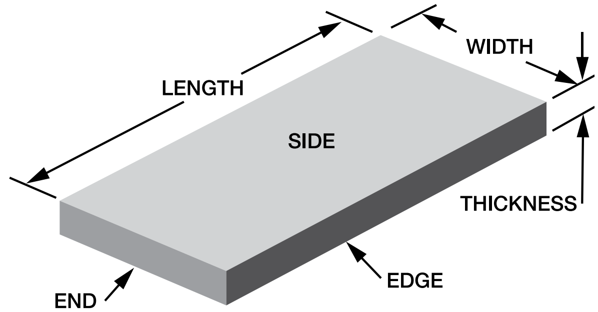
7)



____

Station 1, 2, 3 – Measurement

There is a total of 5 measurement stations that students will rotate through. You will be provided an imperial tape measures to measure 18 objects in 5 stations. All measurements are to be to the nearest 16th of an inch.



Station 1 and 2 consist of 5 objects each that are to be measured with an imperial tape measure. Record the length, width and the thickness of each piece on the worksheet provided on page 18. Station 3 has 5 objects, inside measurements are to be taken and recorded on the worksheet provided on page 18.

Station 4 – Math and Measure

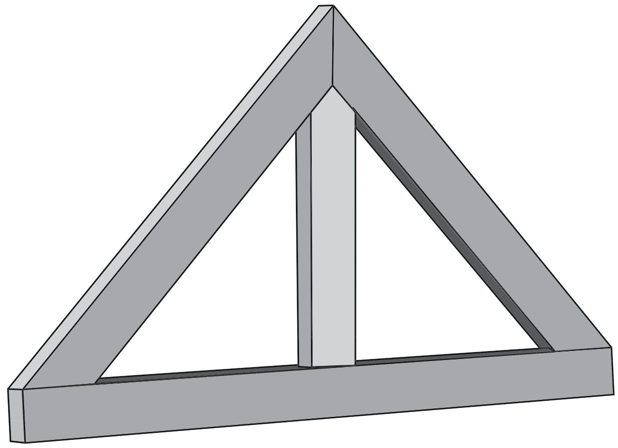
The three triangles in this station are a practical exercise using the Pythagorean Theorem and require the student to physically double-check the math by measuring the hypotenuse. Each triangle has dimensions labelled on the two legs of the right angle. Input these measurements into the Pythagorean Theorem to determine the length of the hypotenuse. Once the solution is calculated, double-check this measurement by measuring the hypotenuse of each triangle. Record you findings on the worksheet provided on page 18.

Station 5 – Measure and Cut

Station 5 is a measure and cut exercise. From the material provided by the instructor produce 1 piece at 24 ¾”, another 14 ⅝”, and 8 ⅛”. Measure carefully; there is little room for error. Pieces are to be presented to the instructor for accuracy and verification.

*Do not proceed until operational and safety training on the mitre saw has been completed.

Station 6 – Roof Truss Construction



Simple triangular roof truss

From the truss plans determine the length of the bottom chord of the truss, (Figure. 1) using the mitre saw cut the bottom chord of the truss to length.

Using the Pythagorean Theorem calculate the length of the top chords (h) (Figure 2). Figure 3 shows the right-angled triangle with legs (a) and (b) identified so (h) can be calculated. The length that is calculated for the top chord is from long point to long point; draw a line at 45˚ using a speed square from these points. Using the mitre saw set to 45˚ cut the two top chords to length.

The length of the vertical member of the truss (z) (Figure 2) needs to be calculated. To find the length of the vertical member of the truss (z) (Figure 2), first determine the shortening (x) (Figure 5) so the piece fits between the top chords and the bottom chord of the truss. In this case, the two legs of the right angle are both 3 ½". The hypotenuse of this triangle (x) is the amount that is subtracted from the total height of the truss. This measurement is from the square bottom to the point on top; the sides of the point are at a 45˚. (Figure 6)

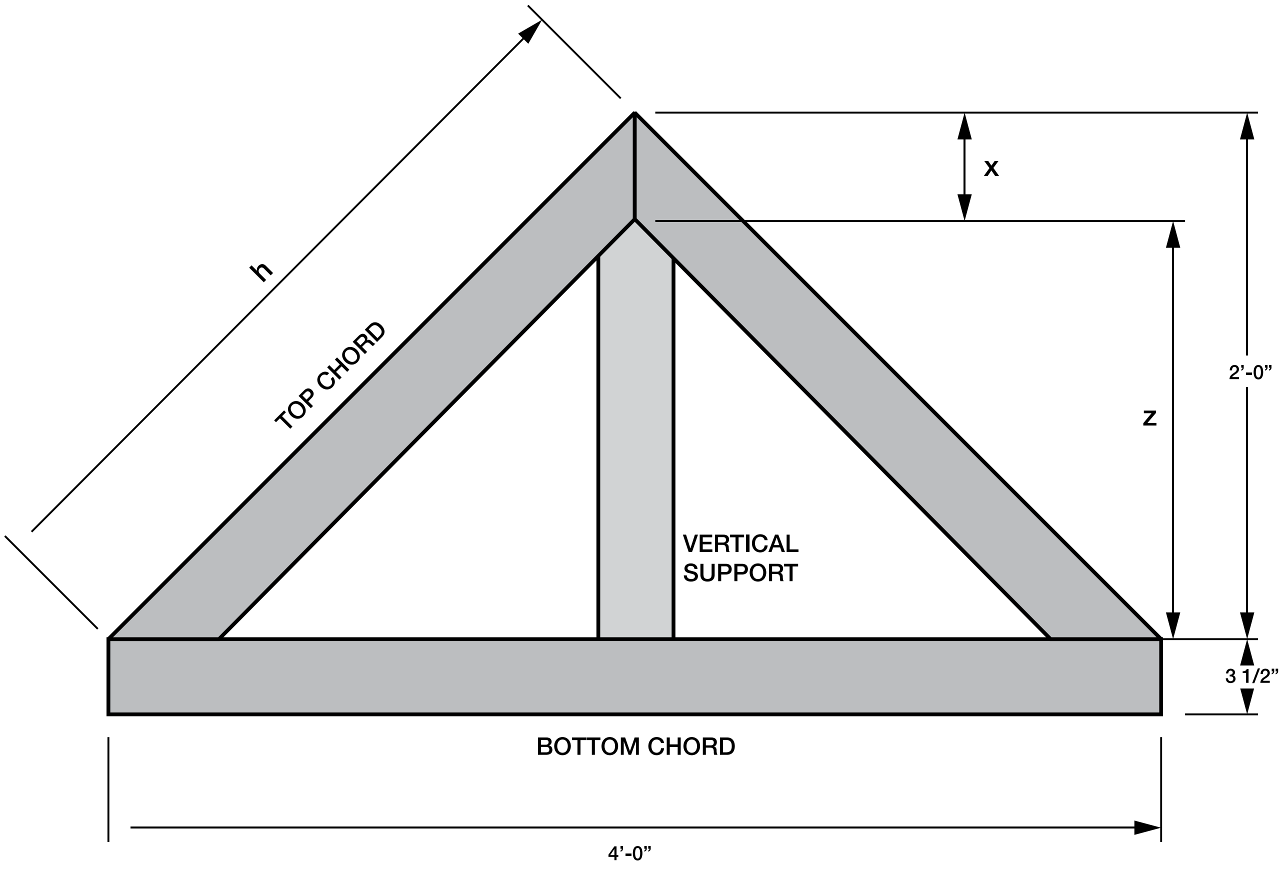
Once the 4 pieces are cut and ready to be assembled the gusset plates need to be laid out and installed. The gusset plates are designed to fit the truss angles and once fastened will provide structure to the truss (Figure 7).One of each gusset plate is to be laid out for nailing according to (Figure 8).

Once completed and checked by the instructor the templates can be used to lay out the rest. Using 1 ¼" ardox nails, fasten each gusset plate to the truss.

The truss is now complete, and the set of trusses from the lesson will be installed on a short wall system that represents a small building. (Figure 9).

Figure 1

Solve for h, x, and z



Solutions

Figure 2

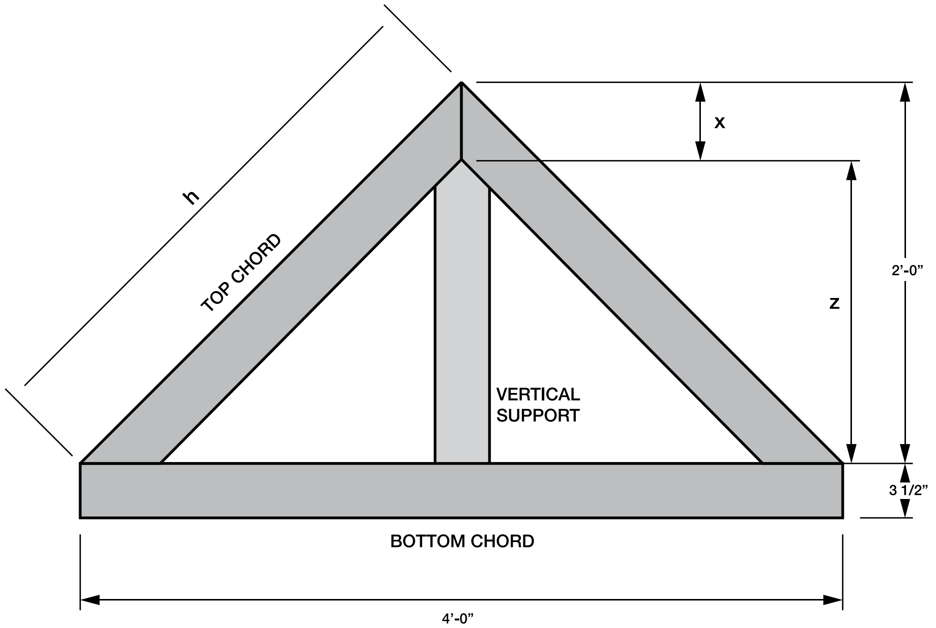
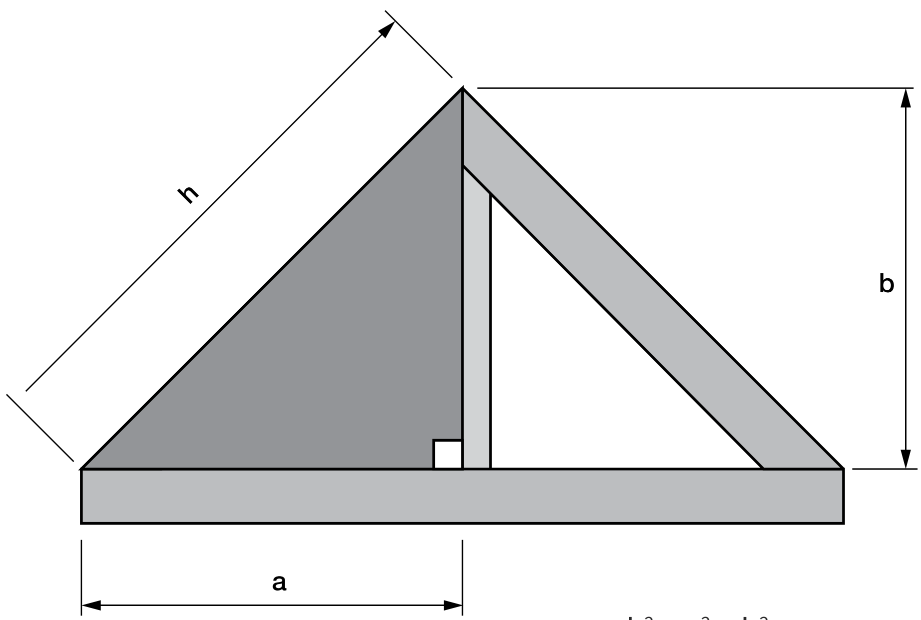


Figure 3



$h^2 = a^2 + b^2$

$h^2 =$

$h^2 =$

$h^2 =$

$h = \sqrt{}$

$h =$

Solutions

Figure 4

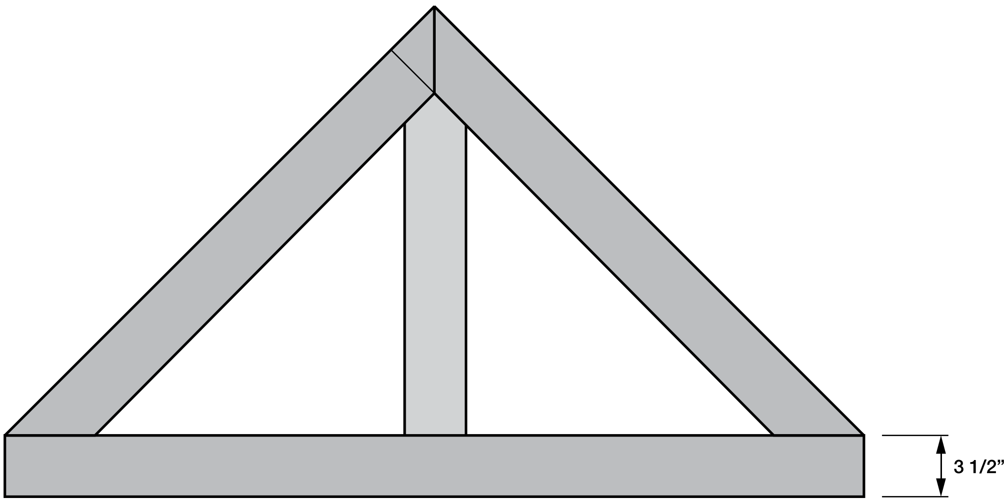
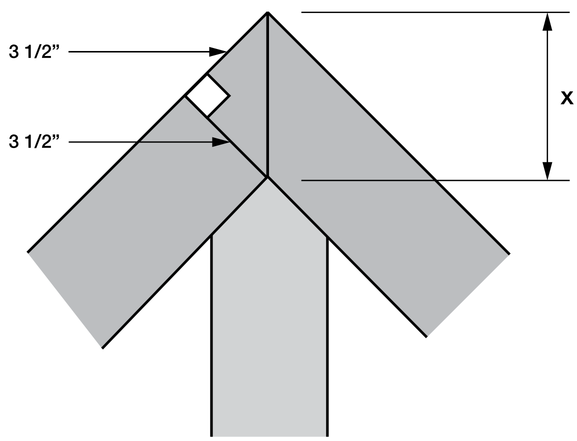


Figure 5



$x^2 = a^2 + b^2$

$x^2 =$

$x^2 =$

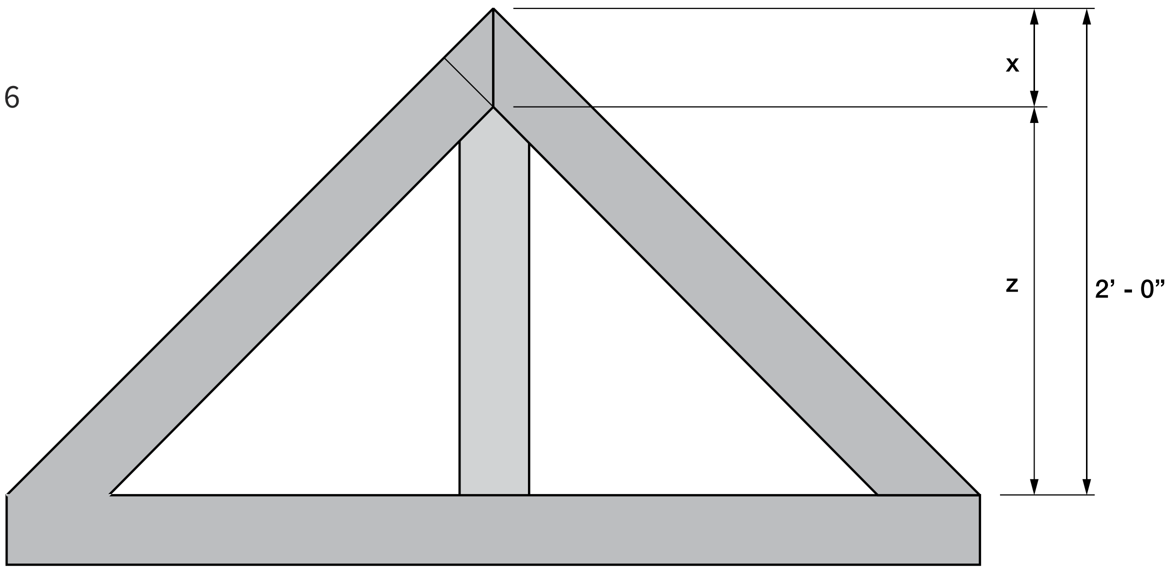
$x^2 =$

$x = \sqrt{}$

$x =$

Solutions

Figure 6



x =
z =
z =

Gussets

Figure 7

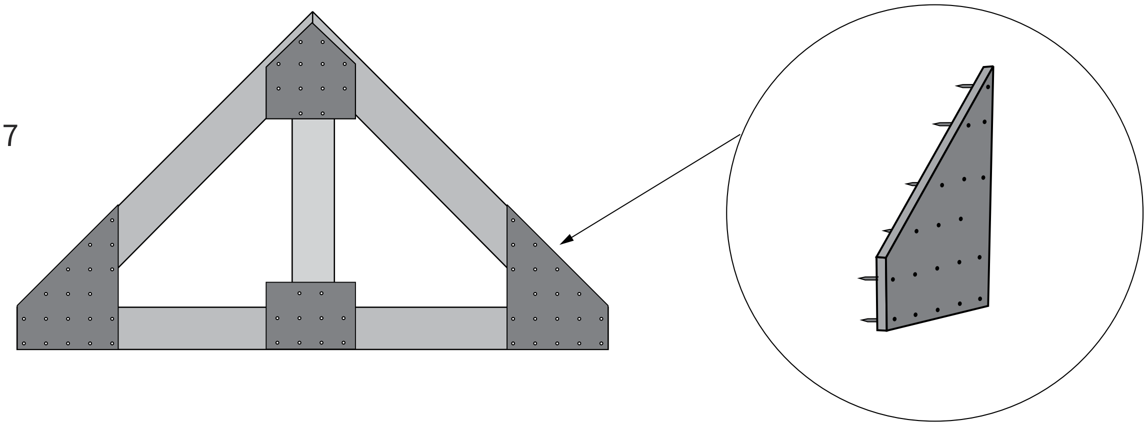
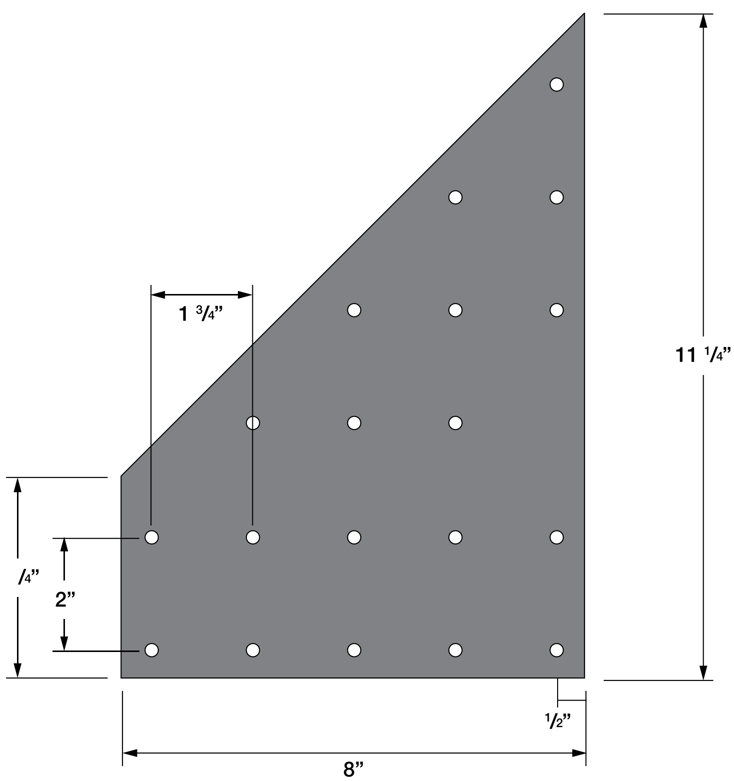
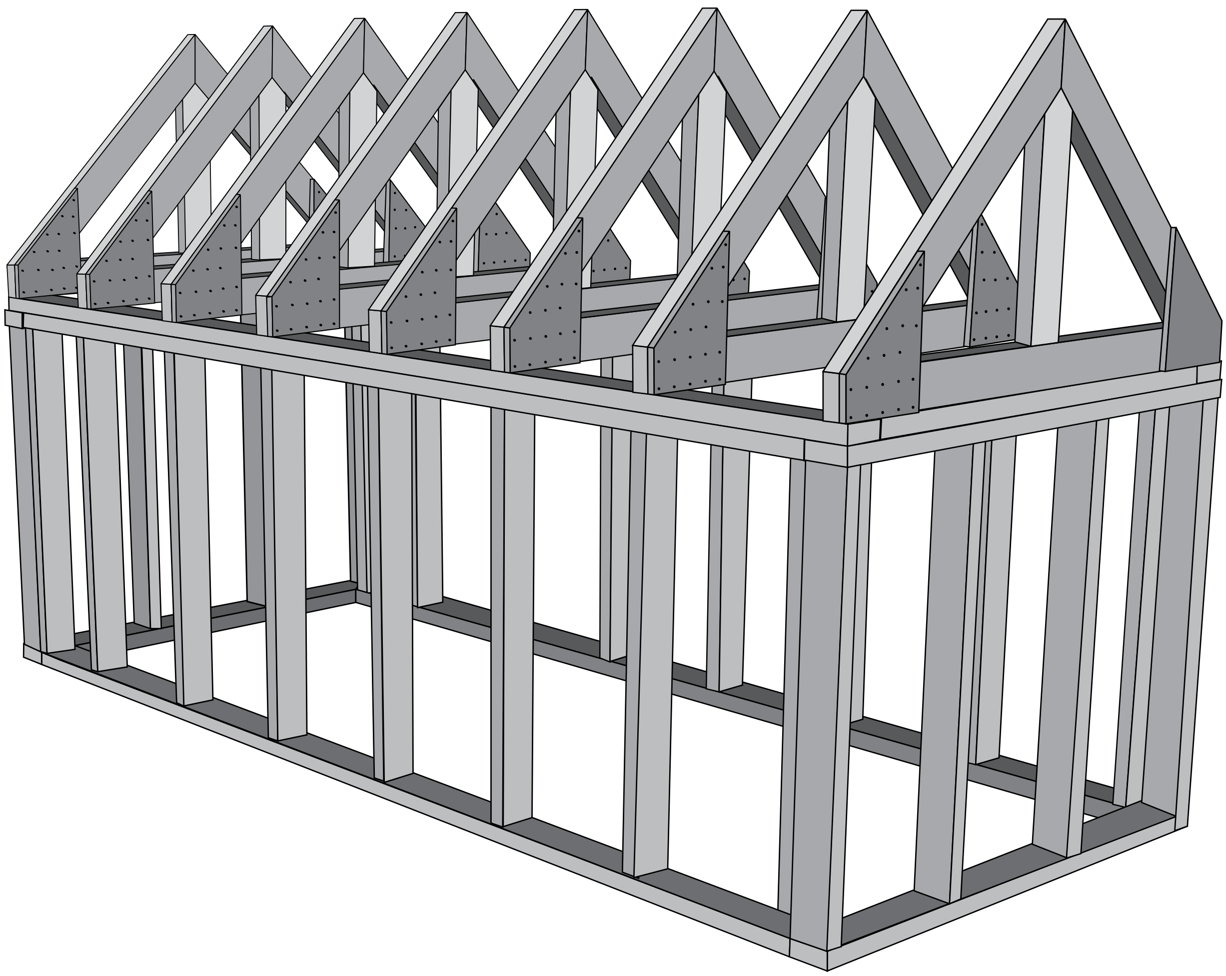


Figure 8



Structure

Figure 9



Station 1				
	Object	Thickness	Width	Length
	1			
	2			
	3			
	4			
	5			

Station 2				
	Object	Thickness	Width	Length
	6			
	7			
	8			
	9			
	10			

Station 3				
	Object	Thickness	Width	Length
	1			
	2			
	3			
	4			
	5			

Station 4				
		a	b	Hypotenuse c
	1			
	2			
	3			