Sheet Metal/ HVAC Pro Calc

Advanced Construction-Math Calculator for Sheet Metal & HVAC Professionals

Model 4090

User's Guide

CALCULATED INDUSTRIES®

FAST. ACCURATE. RELIABLE.

INTRODUCTION

The custom-designed *Sheet Metal/HVAC Pro Calc* calculator was specifically created for sheet metal pro's to ease the task of performing mathematics on the job. It includes the most popular built-in formulas for sheet metal computations, so you'll save time, increase accuracy and eliminate errors.

Your Calculator Helps You Solve:

- Dimensional Math Problems
- Conversions Between Feet-Inch-Fractions, Decimal Feet, Decimal Inches and Metric
- Problems Involving All Common Fractions – *1/2" to 1/64"*
- Area/Volume Calculations
- Arc/Circle/Column/Cone Areas and Volumes
- D:M:S
- Scientific Notation, Cubed Root
- Offset Calculations
- Trigonometry
- Law of Cosines
- Fan Laws 1, 2 and 3
- Velocity/Velocity Pressure Conversions
- Right Angle/Rafter Solutions
- Stair Layout (Risers/Treads), and more!

It also includes handy construction math and material estimation examples — such as right angle/rafter and stair calculations — that will also help you build faster and more accurately.

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KEY DEFINITIONS

BASIC OPERATION KEYS

On/C — ***On/Clear*** — Turns power on. Pressing once clears the display. Pressing twice clears all temporary values.

Off — Turns all power off, clearing all non-permanent registers.

+ − × ÷ = — Arithmetic operation keys.

Conv + — ***Percent (%)*** — Four-function percent. See **page 30** for examples.

0–**9** and **•** — Keys used for entering digits.

← — ***Backspace Key*** — Used to delete entries one key-stroke at a time (unlike the **On/C** function, which deletes the entire entry).

CONVERT Conv KEY — *UNIT CONVERSIONS and SECOND FUNCTIONS*

The **Conv** key is to convert between measurement units or to access second functions, listed below:

Conv — ***Convert*** — Used with the measurement keys to convert between units or with other keys to access special functions.

Conv × — ***Clear All*** — Clears all values, including Memory. Resets all permanent entries to default values (except Preference Settings, which are retained).

Note: Use only when necessary, as it deletes all stored values.

x^2 — Squares the value in the display. For example, to Square the value ten, enter **1** **0** then press **x^2**.

Conv x^2 — ***x^3*** — Cubes the value in the display. For example, to Cube the value ten, enter **1** **0** then press **Conv x^2**.

$\sqrt{x}$ — ***Square Root Function*** — Used to find the Square Root of a non-dimensional or area value (e.g., **1** **0** **0** **$\sqrt{x}$** = 10).

Conv **$\sqrt{x}$** — ***Cube Root Function*** — Used to find the Cube Root of a non-dimensional or volume value (e.g., 1 0 0 0 **Conv** **$\sqrt{x}$** = 10).

Conv **/** — ***x10^y*** — Allows entry of an exponent. For example, 8 **Conv** **/** 1 4 is 8 times 10 to the 14th power ($8x10^{14}$).

Conv **÷** — ***1/x*** — Finds the reciprocal of a number (e.g., 8 **Conv** **÷** = 0.125).

Conv **−** — ***Change (+ / –) Sign*** — Changes the sign of the displayed value to negative or positive.

π — ***Pi*** — Constant = 3.141593

Conv **π** — ***ArcK*** — Constant = 0.017453. This value is equivalent to the constant of a 1° arc angle for a one-unit value. The formula for this constant is π ÷ 180.

Conv **•** — ***Degrees:Minutes:Seconds*** — Converts between D:M:S and Decimal Degree formats.

Note: Your calculator uses a floating d:m:s format (that is, displays decimal degrees to the maximum number of decimal points, for greater accuracy). If you desire rounding to two decimal points (0.00°), you must set your calculator via Preference Settings (see ***page 107****).*

Conv **=** — ***Access Preference Settings*** — Used to access various customizable settings, such as dimensional answer formats (see Preference Settings on **page 107**).

MEMORY and STORAGE FUNCTIONS

Your calculator has two types of Memory:

1) basic Memory or Semi-Permanent, Cumulative **M+**;
2) non-cumulative Storage Registers (M1-M3).

M+ — ***Semi-Permanent Memory*** — Adds any displayed number, dimensioned or unitless, to the semi-permanent, accumulating Memory. Values can be subtracted from this Memory using **Conv** **M+**. **Rcl** **Rcl** will recall and clear the Memory. **Conv** **Rcl** will swap the value stored in accumulative Memory with the value that is currently displayed.

Conv **1** ***Storage Register (M1)*** — Stores the displayed value in non-cumulative, permanent Memory (e.g., **1** **0** **Conv** **1**, **Rcl** **1** = 10). Good for storing a single value, for future reference.

*Note: Non-cumulative means it only accepts one value (does not add or subtract) and a second entered value will replace the first. Permanent means the value is stored even after the calculator is shut off. To delete a stored value, enter a new value or perform a Clear All (**Conv** **✕**).*

Conv **2** ***Storage Register (M2)*** — Same function as **Conv** **1**. *See above.*

Conv **3** ***Storage Register (M3)*** — Same function as **Conv** **1**. *See above.*

RECALL Rcl KEY

The **Rcl** key is used to recall or review stored values (e.g., **Rcl** **θ** to recall a previously entered pitch value). It is also used in reviewing stored settings and Memory operation (see below).

Rcl **Rcl** ***Clear M+*** — Displays and clears M+.

Rcl **M+** ***Recall M+*** — Displays value stored in M+.

Rcl **1** ***Recall M1*** — Recalls the stored value in M1.

Rcl **2** ***Recall M2*** — Recalls the stored value in M2.

Rcl **3** ***Recall M3*** — Recalls the stored value in M3.

FEET-INCH-FRACTION and METRIC KEYS

The following keys are used for entering units of measure, with ease and accuracy:

Feet Enters or converts to Feet. Also used with the ***Inch*** and **/** keys for entering Feet-Inch values (e.g., **6** ***Feet*** **9** ***Inch*** **1** **/** **2**).

*Note: Repeated presses after **Conv** toggle between Feet-Inches and Decimal Feet (e.g., **6** **Feet** **9** **Inch** **1** **/** **2** **Conv** **Feet** = 6.791667 FEET; press **Feet** again to return to Feet-Inch-Fractions).*

Inch Enters or converts to Inches. Also used with the / key for entering fractional inch values (e.g., 9 Inch 1 / 2).

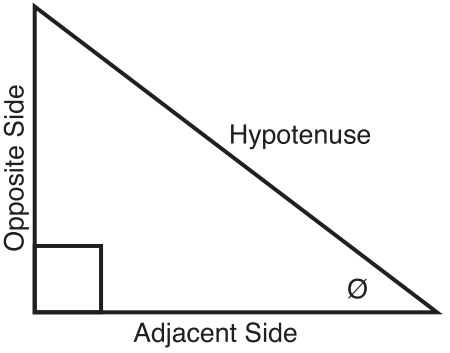
Note: Repeated presses after Conv toggle between Fractional and Decimal Inches (e.g., 9 Inch 1 / 2 Conv Inch = 9.5 INCH; press Inch again to return to Inch-Fractions).

/ ***Fraction Bar*** — Used to enter Fractions. Fractions may be entered as proper (1/2, 1/8, 1/16) or improper (3/2, 9/8). If the denominator (bottom) is not entered, the calculator's fractional resolution setting is automatically used (e.g., entering 1 5 / = or + will display 15/16, based on the default fractional resolution setting of 16ths.

m ***Meters*** — Enters or converts to Meters.

Conv m ***Millimeters*** — Enters or converts to Millimeters.

TRIGONOMETRIC KEYS



Tangent Ø = Opposite / Adjacent

Sine Ø = Opposite / Hypotenuse

Cosine Ø = Adjacent / Hypotenuse

Your calculator has standard trigonometric keys, in addition to Right Triangle keys (e.g., **x**, **y**, **r** and **θ**), for advanced Right Triangle mathematics.

The Sine, Cosine, and Tangent of an angle are defined in relation to the sides of a Right Triangle.

Using the **Conv** key with the trigonometric function gives you the Arcsine, Arccosine and Arctangent – all of which are used to find the Angle for the Sine, Cosine, or Tangent value entered.

Sine — ***Sine Function*** — Calculates the *Sine* of a Degree or undimensioned* value.

Conv **Sine** — ***Arcsine (sin $^{-1}$)*** — Calculates the angle for the entered or calculated Sine value.

Cos — ***Cosine Function*** — Calculates the *Cosine* of a Degree or undimensioned* value.

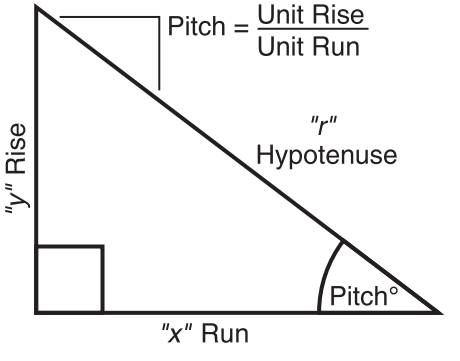
Conv **Cos** — ***Arccosine (cos $^{-1}$)*** — Calculates the angle for the entered or calculated Cosine value.

Tan — ***Tangent Function*** — Calculates the *Tangent* of a Degree or undimensioned* value.

Conv **Tan** — ***Arctangent (tan $^{-1}$)*** — Calculates the angle for the entered or calculated Tangent value.

**Note:* Cannot use on dimensioned values.*

PYTHAGOREAN THEOREM / RIGHT TRIANGLE KEYS



Using the Pythagorean Theorem, the top row of keys on your *Sheet Metal/HVAC Pro Calc* provides instant solutions in dimensional format to Right Triangle problems for sheet metal problems and roof framing.

The Right Triangle is calculated simply by entering two of four variables:

1) x (Run)
2) y (Rise)
3) r (Diagonal, or Hypotenuse); or
4) θ (Theta/Pitch).

x ***Run*** — Enters or calculates "x," or the Run or horizontal leg (base) of a Right Triangle.

y ***Rise*** — Enters or calculates "y," or the Rise or vertical leg (height) of a Right Triangle.

r ***Hypotenuse or Diagonal (for Roof Framing)*** — Enters or calculates the Hypotenuse or diagonal leg of a Right Triangle. Typical applications in construction/framing are "Squaring-up" slabs or finding Common rafter lengths. Additional presses of the **r** key will also display Plumb and Level cut angles in degrees.

Note: The Common rafter calculation is the "point-to-point" length and does not include the overhang or ridge adjustment.

θ ***Theta*** — Enters or calculates the Pitch (slope) of a roof (or Right Triangle). Pitch is the amount of "Rise" over 12 Inches of "Run." Pitch may be entered as:

- a Dimension: 9 Inch θ
- an Angle or Degrees: 3 0 θ
- a Percentage (percent grade): 7 5 Conv + θ

Once a Pitch in one of the above formats is entered, consecutive presses of **θ** will convert to the remaining pitch formats listed above (e.g., Pitch in Inches will convert to Pitch Degrees, Percent Grade and Pitch Ratio/Slope).

Note: An entered (vs. calculated) Pitch is a permanent entry. This means that it will remain stored even after you turn the calculator off. To change the Pitch, simply enter a new Pitch value.

In contrast, a calculated Pitch value is not permanently stored. This means that the calculator will return to the Pitch value you last entered when you press On/C twice.

LAW OF COSINES / NON-90 DEGREE TRIANGLE KEYS

Conv **9** ***Law of Cosines*** — These keys are used for non-90 degree triangle mathematics and are incorporated with Right Triangle mathematics (using "Measured" non-90 degree and "Calculated" Right Triangles), particularly, for finding the dimensional relationship of distance and alignment between two or more objects. The overall purpose of these calculations is to develop the duct and/or fittings required to fill a space.

These keys calculate the opposite angles A, B, and C given entry of Side a, b, and c using the Law of Cosines (see Storage Registers a, b, and c below) and triangle area using Heron's Theorem. They also enable the computation of Right Triangle lengths "*x*," "*y*," "*r*" and Theta, for determining Offset, Length, and Angle.

Press	**Result**
1	Angle A
2	Angle B
3	Angle C
4	Area (using formula for Heron's Theorem)
5	Redisplays entered Side a
6	Redisplays entered Side b
7	Redisplays entered Side c

Conv **4** ***Storage Register "a"*** — Enters Side "a" of a Measured Triangle (e.g., if Side "a" is five feet, enter **5** ***Feet*** **Conv** **4**).

Conv **5** ***Storage Register "b"*** — Enters Side "b" of a Measured Triangle.

Conv **6** ***Storage Register "c"*** — Enters Side "c" of a Measured Triangle.

Right Triangle Functions:

x — ***Length of Unknown Side*** — Calculates Side "x" of unknown Right Triangle.

y — ***Length of Unknown Side*** — Enters Side "y" of unknown Right Triangle.

r — ***Hypotenuse*** — Enters "c" of Measured Triangle as "r" of unknown Right Triangle, for final determination of "x" and "y."

θ — ***Theta*** — Finds unknown angle for determination of "x" and "y."

OFFSET KEYS

Conv **(** — ***Offset*** — Calculates offset measurements, including the Centerline Radius, Wrapper Length/Stretch-out, Heel Radius, Throat Radius and Theta, given entry of "x" (actual length), "y" (offset), and "a" ("end a") into the keys below:

Press	Result
1	Centerline Radius (CR)
2	Wrapper Length/Stretch-out (WL)
3	Heel Radius
4	Throat Radius
5	Theta (THET)
6	Redisplays entered "x" (Actual Length)
7	Redisplays entered "y" (Offset)
8	Redisplays entered "a" (Storage Register "a" or End "a")

x — ***Actual Length*** — Enters the actual length "x" for offset calculations.

y — ***Offset Length*** — Enters the offset "y."

Conv **4** — ***Storage Register "a"*** — Enters length of "end a" for offset calculations.

FAN LAW KEYS

Your calculator also has built-in formulas and keys that calculate Fan Laws 1, 2 and 3, for air flow calculations. Each of these formulas requires the entry of three variables in order to solve the fourth.

Conv ***x*** — ***Fan Law 1*** — Calculates the missing variable (e.g., "a-new" or "b-new" for CFM new or RPM new) for Fan Law 1, given the three known variables into the applicable Storage Registers (see below). See **page 75** for examples.

Conv ***y*** — ***Fan Law 2*** — Calculates the missing variable (e.g., "a-new" or "b-new" for CFM new or SP new) for Fan Law 2, given the three known variables into the applicable Storage Registers (see below). See **page 76** for examples.

Conv ***r*** — ***Fan Law 3*** — Calculates the missing variable (e.g., "a-new" or "b-new" for CFM new or BHP new) for Fan Law 3, given the three known variables into the applicable Storage Registers (see below). See **page 77** for examples.

Storage Registers Used For Fan Laws:

Conv **4** — ***Storage Register "a"*** — Enters "a-old" or current "a" value.

Conv **7** — ***Storage Register "a-new"*** — Enters "a-new" or new "a" value.

Conv **5** — ***Storage Register "b"*** — Enters "b-old" or current "b" value.

Conv **8** — ***Storage Register "b-new"*** — Enters "b-new" or new "b" value.

VELOCITY PRESSURE / FPM KEYS

Conv **0** — ***VP ◄► FPM*** — Converts entry to Velocity (Feet per Minute - FPM), Velocity Pressure, Metric Velocity (MPS) and Metric Velocity Pressure (kPA).

Press	Result
1	*Calculates Velocity (FPM)* – assumes entry is Velocity Pressure
2	*Calculates Velocity Pressure* – assumes entry is Velocity (FPM)
3	*Calculates Metric Velocity (MPS)* – assumes entry is kPA
4	*Calculates Metric Velocity Pressure (kPA)* – assumes entry is MPS

See **page 46** for examples.

CIRCULAR / ARC FUNCTION KEYS

The Circle key helps you quickly solve Circular Area, Volume or Arc problems.

Circ — ***Circle*** — Displays and calculates the following values, given an entered Circle Diameter* or Radius:

- Diameter
- Circumference
- Circle Area

To enter a Diameter (e.g., ten feet), press* **1 **0** ***Feet*** ***Circ***. *To enter a radius, see below.*

Conv **θ** — ***Segment Radius*** — Enters or calculates the Circle Radius (e.g., **5** ***Feet*** **Conv** **θ**). Used to calculate Diameter, Circumference and Circle Area (see above).

Conv ***Circ*** — ***Arc Length or Degree of Arc*** — A multi-function key that enters or calculates Arc Length or Degree of Arc, and further solves for additional Circular/Arc values, including Arched Rake-Walls (based on the stored on-center), listed on next page.

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If a Circle Diameter is entered into the **Circ** key and Arc Degree (or Arc Length) entered into the Arc function (**Conv** **Circ**), further presses of **Circ** will display and calculate the following:

Press	Result
1	Arc Length or Degree of Arc
2	Chord Length
3	Segment Area
4	Pie Slice Area
5	Segment Rise
6	Stored On-Center Spacing
7	Length of Arched Wall 1
8	Length of Arched Wall 2
9	Length of Arched Wall 3 (if applicable), etc.*

Note: The calculator will calculate Arched Rake-Wall stud sizes with consecutive presses of the **Circ key until it reaches the last stud.*

x ***Run (Chord Length)*** — Used with **y** or **Conv** **θ** to find the Chord Length or the Radius of a Circular Segment. If the Segment Rise and Radius have been entered, this key will display the Chord Length of the Circular Segment.

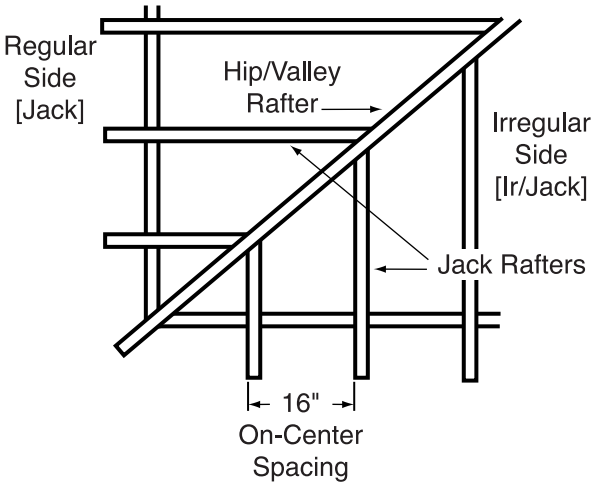
y ***Rise*** — Used with **x** or **Conv** **θ** to find the Rise or the Radius of a Circular Segment. If the Chord Length and Radius have been entered, this key will display the Segment Rise of the Circular Segment.

COLUMN / CONE KEY

The Column and Cone functions help you quickly estimate volume and surface area of Columns or Cones.

Conv **)** ***Column and Cone*** — The first and second press of **)** following **Conv** calculate the total volume and surface area of a *Column* using the values stored in **Circ** and **y**; the third and fourth consecutive presses of **)** calculate the total volume and surface area of a *Cone*.

HIP/VALLEY and JACK RAFTER KEYS



Your calculator uses the *y* (rise), *x* (run), *r* (diagonal), θ (pitch), and o.c. spacing values to calculate Regular (45°) and Irregular (non-45°) Hip/Valley and Jack rafter lengths (excluding wood thickness, etc.).

When calculating Regular and Irregular Jack rafter lengths, you will see the letters "JK" (Common Pitch side) or "IJ" (Irregular Pitch side) and the corresponding Jack number to the left of your calculator display. This will help you keep track of the descending sizes and which side the corresponding rafter is based on.

Hip/V

Hip/Valley Rafter — Finds the Regular (45°) or Irregular (non-45°) Hip/Valley rafter length.

• *Regular Hip/Valley Length:* After Right Triangle/Rafter values are entered or calculated (e.g., Pitch, Rise, Run), pressing Hip/V will calculate the length of the Regular Hip/Valley rafter.

• *Irregular Hip/Valley Length:* If an Irregular Pitch is entered via Conv Hip/V (see next page), pressing Hip/V will calculate the Irregular Hip/Valley rafter length. (An Irregular or "non-standard" roof has two different Pitches/Slopes.)

(Cont'd)

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• Subsequent presses of the **Hip/V** key will also display Plumb, Level, and Cheek cut angle values in degrees.

Conv **Hip/V** ***Irregular Pitch*** — Enters the *Irregular* or Secondary Pitch value used to calculate lengths of the Irregular Hip/Valley and Jack rafters.

You may enter the Irregular Pitch as:

• a Dimension: 9 **Inch** **Conv** **Hip/V**
• an Angle: 3 0 **Conv** **Hip/V**
• a Percentage: 7 5 **Conv** + **Conv** **Hip/V**

Note: An entered Irregular Pitch can be recalled by pressing **Rcl** **Conv** **Hip/V**.

Jack ***Jack Rafters*** — Finds the descending Jack rafter sizes for *Regular* pitched roofs, based on the stored on-center spacing and previously entered or calculated Right Triangle/Rafter values (e.g., Pitch, Rise, Run).

• The default On-Center spacing is 16 Inches. A new On-Center spacing may be entered and permanently stored by entering an Inch value prior to performing the Jack Rafters function (e.g., 1 2 **Inch** **Jack**). The current On-Center spacing value can be viewed by pressing **Rcl** **Jack**.

• Repeated presses of the **Jack** key will display all the rafter sizes (on the regular pitch side) as well as display the Plumb, Level, and Cheek cut angle values. Additional presses will display the rafter sizes on the Irregular Pitch side (if an Irregular Pitch was entered; see above), or repeat the previously displayed values.

Note: You may set your calculator to display the Jack rafter lengths in either ascending or descending order (see Preference Settings on ***page 107****).*

Note: You may program your calculator to "mate up" the Jack rafters, rather than using the entered or default on center for both sides (see Preference Settings on ***page 107****).*

Conv **Jack** ***Irregular Side Jacks*** — Operates same as **Jack**, but displays the rafter values from the irregular pitched side first.

STAIR KEY

Your calculator easily calculates stair layout solutions. Given values for **y** *(Rise)* and/or **x** *(Run)*, your calculator will calculate Riser, Tread, Stringer and Angle of Incline values simply by pressing the **Stair** key.

Stair A multi-function key that uses a stored "desired" Riser height, stored "desired" Tread width, stored Headroom and Floor Thickness, and entered **y** *(Rise)* and/or **x** *(Run)* values to calculate and display the following:

Press	Result
1	Riser Height
2	Number of Risers
3	Riser Overage/Underage
4	Tread Width
5	Number of Treads
6	Tread Overage/Underage
7	Stairwell Opening
8	Stringer Length
9	Angle of Incline*
10	Run (entered or calculated)
11	Rise (entered or calculated)
12	Stored Riser Height
13	Stored Tread Width
14	Stored Headroom Height
15	Stored Floor Thickness

Note: Default values are 7-1/2 Inches for Desired Riser Height and ten Inches for Desired Tread Width, ten Inches for Floor Thickness and 6 Feet 8 Inches for Headroom.

Note: It is not possible for the calculator to include the Nose/Overhang Measurement. Thus, you need to adjust for this measurement per local codes.

**Note: If the inclination angle exceeds the stored Rise and stored Run ratio by 10%, the yield symbol (⚠) will light, indicating a steep incline.*

Conv Stair — ***Store Desired Riser Height*** — Stores a value *other than the default desired stair Riser height of 7-1/2 Inches* (e.g., 8 Inch Conv Stair stores an eight-inch desired stair Riser height). To recall the stored setting, press Rcl Stair.

Conv − − − − — ***Store Desired Tread Width*** — Stores a value *other than the default desired stair Tread width of ten inches.* See **page 107** Preference Settings to view how to use the + and − key to increase or decrease stored Tread width.

Conv − − − − − — ***Store Headroom Height*** — Stores a value *other than the default desired Headroom Height of six Feet eight Inches*, for calculation of stairwell opening. See **page 107** Preference Settings to view how to use the + and − key to increase or decrease stored Headroom height.

Conv − − − − − − — ***Store Floor Thickness*** — Stores a value *other than the default desired Floor Thickness of ten Inches*. See **page 107** Preference Settings to view how to use the + and − key to increase or decrease stored Floor Thickness.

You may want to practice getting a feel for your calculator keys by reading through the key definitions and learning how to enter basic Feet-Inch-Fractions and Metric, how to store values in Memory, etc., before proceeding to the examples.

You may also want to glance at various formulas listed in the Appendix, so you understand what mathematical calculations your calculator is programmed to perform, or common formulas you can refer to on the job. Also review specific default settings or Preference Settings, listed in the Appendix.

ORDER OF OPERATIONS

Unlike other Calculated Industries' calculators, which use the Chaining Method of Operations, this calculator uses the Order of Operations Method.

— Chaining Method ("as entered"): 10 + 4 x 5 = 70

— Order of Operations Method: 10 + 4 x 5 = 30

The Order of Operations method of computing is based on the following order of preference:

1) Expressions inside of parentheses
2) Single-variable functions that perform the calculation and display the result immediately (Trig functions, Square, Square Root, Cube, Cube Root, Log, Percent, Reciprocal, Angle Conversions)
3) Exponential function
4) Multiplication and Division
5) Addition and Subtraction
6) Equals (completes all operations)

If you need to calculate using the Chaining Method, you can change this in your calculator Preference Settings. See **page 107** for instructions.

USING PARENTHESES

Your calculator has Parentheses keys (and) for performing mathematical operations. (In the Order of Operations method, expressions inside of parentheses are performed first.)

The calculator offers four levels of parenthesis:

1) *First parenthesis level opened* – press (for one Right-Sided Parenthesis.
2) *Second level opened* – press (a second time for two Right-Sided Parentheses ((.
3) *Third level opened* – press (a third time for three Right-Sided Parentheses (((.
4) *Fourth level opened* – press (a fourth time for four Right-Sided Parentheses ((((.

As you close each level of Parenthesis, the displayed number of Parentheses in the upper left corner of the LCD is reduced by one, and the results of the expression are displayed.

SETTING FRACTIONAL RESOLUTION

Your calculator is set to display fractional answers in 16ths, and all examples in this User Guide are, therefore, based on 1/16ths. However, you may select the fractional resolution to be displayed in other formats (e.g., 1/64ths, 1/32nds, etc.). Follow the two options for selecting fractional resolution below.

Setting Fraction Resolution to Other Than 16ths — *Using the Preference Setting Mode*

KEYSTROKE	DISPLAY
1. Access Preference Settings:	
Conv = *(default setting = 1/16th of an Inch)*	**FRAC 0-1/16 INCH**
2. Access Next Fraction Sub-setting:	
+	**FRAC 0-1/32 INCH**
+	**FRAC 0-1/64 INCH**
+	**FRAC 0-1/2 INCH**
+	**FRAC 0-1/4 INCH**
+	**FRAC 0-1/8 INCH**
+ *(returns to 16ths)*	**FRAC 0-1/16 INCH**
3. To Permanently Set the Fraction Resolution You Have Selected Above, Press On/C or Any Key to Exit:	
On/C	**0.**
4. To Recall Your Selected Fraction Resolution:	
Rcl /	**STD 0-1/16 INCH**

Setting Fixed/Constant Fractional Resolution

You can also program your calculator so that the displayed fraction will *always* show in the fractional resolution you have set (following the above instructions). That is, instead of solving for the closest fraction, it will always display the chosen fractional resolution. For example, if you have chosen 1/64ths, 1/2 will be displayed as 32/64.

If you do not use this feature, Standard Fractional Resolution will be displayed. In other words, in the above example, 1/2 will be displayed as 1/2.

To change your calculator to Fixed (or Constant) Fractional Resolution:

KEYSTROKE	DISPLAY
1. Access Preference Settings:	
Conv =	**FRAC 0-1/16 INCH**
2. Press = 12 times to access Fixed/Constant Fractional Resolution setting:	
= *(twelfth press of =)*	**FRAC Std.**
3. Change setting by pressing + :	
+	**FRAC COnSt**
+ *(returns to Standard)*	**FRAC Std.**
4. To permanently set the Fixed/Constant Fractional Resolution setting, press On/C or any key to exit.	
On/C	**0.**
5. To recall your selected Fixed/Constant Fractional Resolution setting:	
Rcl / *(default settings)*	**STD 0-1/16 INCH**

ENTERING DIMENSIONS

Entering Linear Dimensions

When entering Feet-Inch-Fraction values, enter dimensions from largest to smallest — e.g., Feet before Inches, Inches before Fractions. Enter Fractions by entering the numerator (top), pressing / (Fraction bar key) and then the denominator (bottom).

Note: If a denominator is not entered, the fractional setting value is used.

Examples (press On/C after each one):

DIMENSION	KEYSTROKES
5 Feet 1-1/2 Inch	5 Feet 1 Inch 1 / 2
17.5 Meters	1 7 • 5 m
32 Millimeters	3 2 Conv m

Entering Square/Cubic Dimensions

Your calculator lets you easily enter Square and Cubic values. Simply press a dimensional unit key two times to label a number as a Square value, or three times to label a Cubic value.

Note: If you pass the desired dimensional format, keep on pressing the dimensional unit key until the desired result is displayed.

Enter Square and Cubic dimensions in the following order:

(1) Enter numerical value (e.g., 1 0 0).
(2) Press desired unit key (e.g., Feet) to label value as "linear."

KEYSTROKE	DISPLAY
On/C On/C	0.
1 0 0 Feet	100 FEET

(3) Second consecutive press of unit key (e.g., Feet) labels value as "Square."

KEYSTROKE	DISPLAY
On/C On/C	0.
1 0 0 Feet Feet	100 SQ FEET

(4) Third consecutive press of unit key labels value as "Cubic."

KEYSTROKE	DISPLAY
On/C On/C	0.
1 0 0 Feet Feet Feet	100 CU FEET

Note: Feet-Inch format cannot be used to enter Square or Cubic values.

Examples of Square and Cubic Entry:

FEET

Feet Feet — Square Feet
(e.g., 5 **Feet** **Feet** will display **5.** SQ FEET).

Feet Feet Feet — Cubic Feet
(e.g., 5 **Feet** **Feet** **Feet** will display **5.** CU FEET).

INCHES

Inch Inch — Square Inches
(e.g., 5 **Inch** **Inch** will display **5.** SQ INCH).

Inch Inch Inch — Cubic Inches
(e.g., 5 **Inch** **Inch** **Inch** will display **5.** CU INCH).

METERS

m m — Square Meters
(e.g., 5 **m** **m** will display **5.** SQ M).

m m m — Cubic Meters
(e.g., 5 **m** **m** **m** will display **5.** CU M).

MILLIMETERS

Conv m m — Square Millimeters
(e.g., 5 **Conv** **m** **m** will display **5.** SQ MM).

Conv m m m — Cubic Millimeters
(e.g., 5 **Conv** **m** **m** **m** will display **5.** CU MM).

CONVERSIONS (LINEAR, AREA, VOLUME)

Linear Conversions

Convert 14 Feet to other dimensions:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 4 Feet	14 FEET
Conv Inch	168 INCH
m*	4.267 M
Conv m *(mm)*	4267.2 MM

**Note*: When performing multiple conversions, you only have to press the Conv key once (except when accessing secondary functions (Millimeters), e.g., Conv m).*

Converting Feet-Inch-Fractions to Decimal Feet

Convert 15 Feet 9-1/2 Inches to Decimal Feet. Then convert back to Feet-Inch-Fractions.

KEYSTROKE	DISPLAY
On/C On/C	0.
1 5 Feet 9 Inch 1 / 2	15 FEET 9-1/2 INCH
Conv Feet	15.79167 FEET
Feet	15 FEET 9-1/2 INCH

Converting Decimal Feet to Feet-Inch-Fractions

Convert 17.32 Feet to Feet-Inch-Fractions.

KEYSTROKE	DISPLAY
On/C On/C	0.
1 7 • 3 2 Feet	17.32 FEET
Conv Feet	17 FEET 3-13/16 INCH

Converting Fractional Inches to Decimal Inches

Convert 8-1/8 Inches to Decimal Inches. Then convert to Decimal Feet.

KEYSTROKE	DISPLAY
On/C On/C	0.
8 Inch 1 / 8	8-1/8 INCH
Conv Inch	8.125 INCH
Feet	0.677083 FEET

Converting Decimal Inches to Fractional Inches

Convert 9.0625 Inches to Fractional Inches. Then convert to Decimal Feet.

KEYSTROKE	DISPLAY
On/C On/C	0.
9 • 0 6 2 5 Inch	9.0625 INCH
Conv Inch	9-1/16 INCH
Feet Feet	0.755208 FEET

Square Conversions

Convert 14 Square Feet to other Square dimensions:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 4 Feet Feet Conv Inch	2016. SQ INCH
m	1.300643 SQ M
Conv m *(mm)*	1300642.^{56*} SQ MM

**For larger digit displays, the numerator section is utilized for decimal displays.*

Cubic Conversions

Convert 14 Cubic Feet to other Cubic dimensions:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 4 Feet Feet Feet Conv Inch	24192. CU INCH
m	0.396436 CU M

PERFORMING BASIC MATH WITH DIMENSIONS

Adding Dimensions

KEYSTROKE	DISPLAY
Add 11 Inches to 2 Feet 1 Inch:	
1 1 Inch + 2 Feet 1 Inch =	3 FEET 0 INCH
Add 5 Feet 7-1/2 Inches to 18 Feet 8 Inches:	
5 Feet 7 Inch 1 / 2 + 1 8 Feet 8 Inch =	24 FEET 3-1/2 INCH

Subtracting Dimensions

KEYSTROKE	DISPLAY
Subtract 3 Feet from 11 Feet 7-1/2 Inches:	
1 1 Feet 7 Inch 1 / 2 − 3 Feet =	8 FEET 7-1/2 INCH
Subtract 32 Inches from 81 Inches:	
8 1 Inch − 3 2 Inch =	49 INCH

Multiplying Dimensions

KEYSTROKE	DISPLAY
Multiply 5 Feet 3 Inches by 11 Feet 6-1/2 Inches:	
5 Feet 3 Inch × 1 1 Feet 6 Inch 1 / 2 =	60.59375 SQ FEET
Multiply 2 Feet 7 Inches by 10:	
2 Feet 7 Inch × 1 0 =	25 FEET 10 INCH

Dividing Dimensions

KEYSTROKE	DISPLAY
Divide 30 Feet 4 Inches by 7 Inches:	
3 0 Feet 4 Inch ÷ 7 Inch =	52.
Divide 20 Feet 3 Inches by 9:	
2 0 Feet 3 Inch ÷ 9 =	2 FEET 3 INCH

Percentage Calculations

Percent (Conv +) is used to find a given percent of a number or to perform add-on, discount or division percentage calculations. You may also perform percentage calculations with dimensional units (Feet, Inch, etc.), in any format (Linear, Square or Cubic).

Examples:

KEYSTROKE	DISPLAY
Find 18% of 500 Feet:	
5 0 0 Feet × 1 8 Conv +	**90 FEET 0 INCH**
What is 15% of $250?	
2 5 0 × 1 5 Conv +	**37.5**
Add 10% to 137 Square Feet:	
1 3 7 Feet Feet + 1 0 Conv +	**150.7 SQ FEET**
Subtract 20% from 552 Feet 6 Inches:	
5 5 2 Feet 6 Inch − 2 0 Conv +	**442 FEET 0 INCH**
Divide 350 Meters by 80%:	
3 5 0 m ÷ 8 0 Conv +	**437.500 M**

MEMORY OPERATION

Your calculator has two types of Memory operations:

1) A Standard, Cumulative, Semi-permanent Memory **M+**; and
2) Three Storage Registers **[M1]**, **[M2]** and **[M3]**, used to permanently store single, non-cumulative values.

Memory commands are listed below.

FUNCTION	KEYSTROKES
M+:	
Add value to M+	M+
Subtract value from M+	Conv M+
Clear M+ *(displays and clears M+)*	Rcl Rcl
M+ Swap *(swaps current value stored in M+ with displayed value)*	Conv Rcl
Recall stored value	Rcl M+
M1/M2/M3:	
Store single value in M1	Conv 1
Store single value in M2	Conv 2
Store single value in M3	Conv 3
Clear register M1	0 Conv 1
Clear register M2	0 Conv 2
Clear register M3	0 Conv 3
Recall stored value in M1	Rcl 1
Recall stored value in M2	Rcl 2
Recall stored value in M3	Rcl 3

i. Basic Cumulative Memory (M+)

Example 1:

Store 100 into M+, add 200, then subtract 50. Clear the Memory:

KEYSTROKE	DISPLAY
1 0 0 M+	M+ 100. M
2 0 0 M+	M+ 200. M
5 0 Conv M+	M– 50. M
Rcl Rcl	M+ 250.

Note: To Clear Memory (M+):
- press Rcl Rcl; or
- turn off the calculator.

Example 2:

Store 100 into M+, then replace this value with 200 using Memory Swap:

KEYSTROKE	DISPLAY
1 0 0 M+	M+ 100. M
Rcl M+	M+ STORED 100. M
2 0 0 Conv Rcl	SWAP 100. M
Rcl M+	M+ STORED 200. M
Rcl Rcl	M+ 200.

ii. Permanent Storage Registers (M1, M2, and M3)

Examples:

Store a rate of $175 into M1 and recall the value:

KEYSTROKE	DISPLAY
1 7 5 Conv 1	M-1 175.
Off On/C	0.
Rcl 1	M-1 STORED 175.

Store 1,575 Square Meters into M2 and recall the value:

KEYSTROKE	DISPLAY
1 5 7 5 m m Conv 2	M-2 1575. SQ M
Off On/C	0.
Rcl 2	M-2 STORED 1575. SQ M

Note: To Clear M1-M3: Values stored in M1-M3 will remain permanently stored, even after you turn the calculator off. You will never need to clear the storage registers; simply enter a new value. However, if you wish to clear M1-M3 to "zero":
- Enter 0 Conv 1, 0 Conv 2 or 0 Conv 3

EXAMPLES — *USING THE SHEET METAL/HVAC PRO*

The *Sheet Metal/HVAC Pro Calc* calculator has keys and functions labeled in common sheet metal/HVAC or construction terms. Just follow the examples and adapt the keystrokes to your specific application.

Your calculator will save you time; you don't need to remember common formulas, as they are built into timesaving keys.

The first examples that follow provide you with mathematical problems seen in the sheet metal industry, such as computing triangle measurements using the Pythagorean Theorem or the Law of Cosines, as well as dedicated Offset, Fan Law, and Velocity functions.

The remaining examples apply to the construction trades, especially roof framing, which also depends on Right Triangle mathematics.

It is good practice to clear your calculator (press **On/C** twice) before beginning each problem. And remember to use the Backspace (⬅) key to correct entries one entry at a time.

BASIC EXAMPLES

Adding Linear Measurements

Find the total length of the following measurements: 5 Feet 4-1/2 Inches, 8 Inches and 3.5 Meters.

KEYSTROKE	DISPLAY
1. Add the measurements:	
On/C On/C	0.
5 Feet 4 Inch 1 / 2 +	5 FEET 4-1/2 INCH
8 Inch +	6 FEET 0-1/2 INCH
3 • 5 m	3.5 M
2. Find the total:	
=	17 FEET 6-5/16 INCH

Converting Feet-Inch-Fractions to Decimal Feet and Fractions of an Inch

Convert 5 Feet 7-1/2 Inches to Decimal Feet, then Decimal Inches and Inch-Fractions:

KEYSTROKE	DISPLAY
On/C On/C	0.
5 Feet 7 Inch 1 / 2	5 FEET 7-1/2 INCH
Conv Feet	5.625 FEET
Inch	67.5 INCH
Inch	67-1/2 INCH

Converting Feet-Inches to Meters and Millimeters

Convert 8 Feet 6 Inches to Meters and Millimeters:

KEYSTROKE	DISPLAY
On/C On/C	0.
8 Feet 6 Inch Conv m	2.591 M
Conv m *(mm)*	2590.8 MM

Adding and Subtracting Fractions of an Inch

Add 1/2 Inch, 3/8 Inch and 11/16 Inch. Then subtract 5/8 Inch.

KEYSTROKE	DISPLAY
On/C On/C	0.
1 / 2 + 3 / 8 + 1 1 / 1 6 =	1-9/16 INCH
− 5 / 8 =	0-15/16 INCH

Converting Fractions to Decimals

Convert 7/32 Inch and 1/3 Inch to Decimals, respectively (and round answers):

KEYSTROKE	DISPLAY
On/C On/C	0.
7 / 3 2 Conv Inch	0.21875 INCH
	(Answer = 0.219")
1 / 3 Conv Inch	0.333333 INCH
	(Answer = 0.33")

Converting Decimals to Fractions

Convert 5.875 Inches and 8.545 Inches to the nearest 16ths of an Inch:

KEYSTROKE	DISPLAY
On/C On/C	0.
5 • 8 7 5 Inch Conv Inch	5-7/8 INCH
8 • 5 4 5 Inch Conv Inch	8-9/16 INCH

Finding Length (of Iron) Required

What is the length of iron required if you need twenty (20) pieces measuring 5-1/16 Inches each? If you allow 3/32 Inch for each cut, what is the new length required?

KEYSTROKE	DISPLAY
On/C On/C	0.
5 Inch 1 / 1 6 × 2 0 =	101-1/4 INCH
M+	M+ 101-1/4 INCH M
3 / 3 2 × 1 9 =	1-25/32 INCH M
M+	M+ 1-25/32 INCH M
Rcl M+	M+ STORED 103-1/32 INCH M
Rcl Rcl *(clear Memory)*	M+ 103-1/32 INCH

Circumference of a Circle

Find the Circumference of a Circle if its Radius is 8 Feet 4 Inches:

KEYSTROKE	DISPLAY
On/C On/C	0.
8 Feet 4 Inch Conv θ	RAD 8 FEET 4 INCH
Circ	DIA 16 FEET 8 INCH
Circ	CIRC 52 FEET 4-5/16 INCH

Circumference and Area of a Circle

Find the Area and Circumference of a Circle with a Diameter of 11 Inches:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 1 Inch Circ	DIA 11 INCH
Circ	CIRC 34-9/16 INCH
Circ	AREA 95.03318 SQ INCH

Square Area (x^2)

What is the Area of a Square room with sides measuring 7 Feet 4 Inches?

KEYSTROKE	DISPLAY
On/C On/C	0.
7 Feet 4 Inch x^2	53.77778 SQ FEET

Area of a Rectangle

What is the Area of a room measuring 12 Feet 6 Inches by 15 Feet 8 Inches?

KEYSTROKE	DISPLAY
On/C On/C	0.
1 2 Feet 6 Inch	12 FEET 6 INCH
× 1 5 Feet 8 Inch =	195.8333 SQ FEET

Area of a Triangle

Find the Area of a Triangle if its base is 45 Inches and Altitude/ Height is 30 Inches.

KEYSTROKE	DISPLAY
On/C On/C	0.
4 5 Inch ÷ 2 =	22-1/2 INCH
× 3 0 Inch =	675. SQ INCH

Volume of a Rectangular Box

Find the Volume of a rectangular box with Length of 15 Inches, Width of 6 Inches and Height 9-1/2 Inches.

KEYSTROKE	DISPLAY
On/C On/C	0.
1 5 Inch × 6 Inch × 9 Inch 1 / 2 =	855. CU INCH

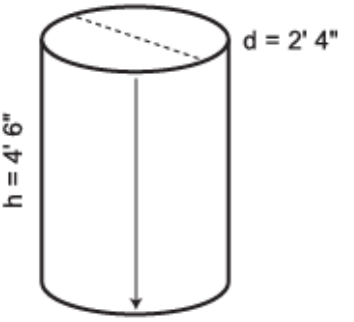
Volume of a Rectangular Container, Converting to Cubic Meters

What is the Volume of a rectangular container that measures 3 Feet by 1 Foot 9-5/8 Inches by 2 Feet 4 Inches?

KEYSTROKE	DISPLAY
1. Find Volume in Cubic Feet:	
On/C On/C	0.
3 Feet	3 FEET
× 1 Feet 9 Inch 5 / 8	1 FEET 9-5/8 INCH
× 2 Feet 4 Inch =	12.61458 CU FEET
2. Convert to Cubic Meters:	
Conv m	0.357205 CU M

Volume of a Cylinder

Calculate the Volume of a Cylinder with a Diameter of 2 Feet 4 Inches and a Height of 4 Feet 6 Inches:



Note: For a Cylinder, use the Column ❩ function.

KEYSTROKE	DISPLAY
1. First, enter Diameter to find Circle Area:	
On/C On/C	**0.**
2 Feet 4 Inch Circ	**DIA 2 FEET 4 INCH**
Circ Circ	**AREA 4.276057 SQ FEET**
2. Enter Height and find Volume of Column (or Cylinder):	
4 Feet 6 Inch y	**Y 4 FEET 6 INCH**
Conv ❩	**COL 19.24226 CU FEET**

Volume of a Cone

Calculate the Volume of a Cone with a Diameter of 3 Feet 6 Inches and a Height of 5 Feet:

KEYSTROKE	DISPLAY
1. Find Circle Area:	
On/C On/C	**0.**
3 Feet 6 Inch Circ	**DIA 3 FEET 6 INCH**
Circ Circ	**AREA 9.621128 SQ FEET**
*2. Enter Height and find Volume:**	
5 Feet y	**Y 5 FEET 0 INCH**
Conv ❩ ❩ ❩*	**CONE 16.03521 CU FEET**

**Note: To access Cone Volume, notice you must press the ❩ key three times after Conv.*

Cubed Function

What is the Cubed value of 10? What is 50^3?

KEYSTROKE	DISPLAY
On/C On/C	0.
1 0 Conv x^2	1000.
5 0 Conv x^2	125000.

Cubed Root Function

Example 1:

What is the Cubed Root of 100? Then, find $\sqrt[3]{5088}$:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 0 0 Conv $\sqrt{x}$	4.641589
5 0 8 8 Conv $\sqrt{x}$	17.1995

Example 2:

What are the three dimensions of a Cube with a Volume of 2028 Cubic Inches?

KEYSTROKE	DISPLAY
On/C On/C	0.
2 0 2 8 Conv $\sqrt{x}$	**12.65773** *(Inches)*

Alternate method of entry using Unit Keys:

KEYSTROKE	DISPLAY
On/C On/C	0.
2 0 2 8 Inch Inch Inch	2028 CU INCH
Conv $\sqrt{x}$	12-11/16 INCH
Conv Inch Inch	12.65773 INCH

Scientific Notation

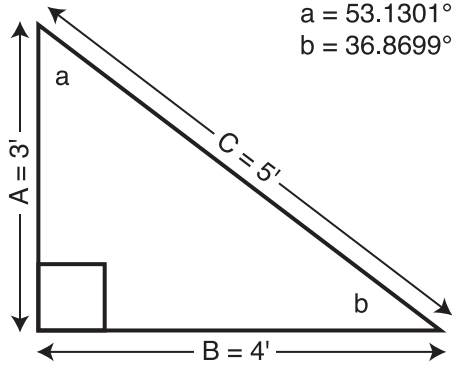
Add 1.78×10^{10} and 3.90×10^9:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 • 7 8 Conv / 1 0 + 3 • 9 Conv / 9 =	2.17000^{10}

TRIGONOMETRIC FUNCTIONS

Trigonometric functions are available on the *Sheet Metal/HVAC Pro Calc* calculator.

The drawing and formulas below list basic trigonometric formulas, for your reference:



Given side A and angle a, find:

Side C	A ÷ a Cos =
(i.e., 3 Feet ÷ 5 3 • 1 3 Cos =)	
Side B	A × a Tan =
Angle b	90° − a =

Given side A and angle b, find:

Side B	A ÷ b Tan =
Side C	A ÷ b Sine =
Angle a	90° − b =

Given side B and angle a, find:

Side A	B ÷ a Tan =
Side C	B ÷ a Sine =

Given side C and angle a, find:

Side A	C × a Cos =
Side B	C × a Sine =

Given side A and side C, find:

Angle a	A ÷ C = Conv Cos
Angle b	A ÷ C = Conv Sine

Given side B and angle b, find:

Side C	B ÷ b Cos =
Side A	B × b Tan =

Finding Sine, Cosine, Tangent

Find Sine 12°, Cosine 33° and Tangent 75°:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 2 Sine	0.207912
3 3 Cos	0.838671
7 5 Tan	3.732051

Finding "Angle A" (ArcSin, ArcCos, ArcTan)

Find Angle A if Sine A = 0.57544, Cosine A = 0.06753 and Tangent A = 0.87421 and round to the nearest whole angle:

KEYSTROKE	DISPLAY
On/C On/C	0.
• 5 7 5 4 4 Conv Sine	35.13045° (35°)
• 0 6 7 5 3 Conv Cos	86.12787° (86°)
• 8 7 4 2 1 Conv Tan	41.16028° (41°)

Using Trigonometry to Find Unknown Side

Using the Pythagorean Theorem ($a^2 + b^2 = c^2$) keys, find Side a ("x") of a Right Triangle, if Side b ("y") is 6-1/2 Inches and Side c ("r"), the Hypotenuse, is 12-1/16 Inches.

Note: Use the calculator's x, y and r keys; substitute triangle legs a, b and c for [x], [y] and [r].

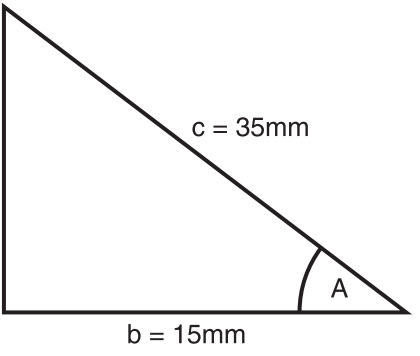
KEYSTROKE	DISPLAY
On/C On/C	0.
6 Inch 1 / 2 y	Y 6-1/2 INCH
1 2 Inch 1 / 1 6 r	R 12-1/16 INCH
x	X 10-3/16 INCH

Using Trigonometry to Find Unknown Angle or Side

Example 1 — Cos A:

Solve for the unknown angle A if the two known sides are:

Side b = 15 mm
Side c = 35 mm



a) Longhand Method: In this case, use the trigonometry formula:
Cos = Adjacent/Hypotenuse or cos A = b/c

KEYSTROKE	DISPLAY
On/C On/C	0.
1 5* ÷ 3 5 = Conv Cos	64.62307°
	(64.6°)
Conv •	DMS 64.37.23

**Note*: you do not have to label mm.*

b) Alternative Method (Use Pythagorean Theorem Keys):
Insert values into x, y, or r keys to solve for Theta.

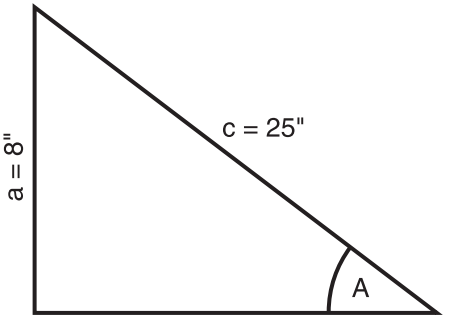
KEYSTROKE	DISPLAY
On/C On/C	0.
1 5 x	X 15.
3 5 r	R 35.
θ	64.62307°
	(64.6°)
Conv •	DMS 64.37.23

Trig Examples *(Cont'd)*

Example 2 — Sin A:

Solve angle A of the offset below, if the two known sides are:

Side a = 8 Inches
Side c = 25 Inches



In this case, use the trigonometry formula:
Sin = Opposite/Hypotenuse or Sin A = a/c

a) Longhand/Use Sine Formula:

KEYSTROKE	DISPLAY
On/C On/C	0.
8 ÷ 2 5 = Conv Sine	18.66292°
	(18.7°)

b) Use Pythagorean Theorem Keys:

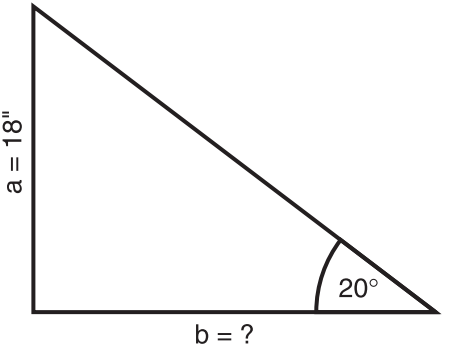
KEYSTROKE	DISPLAY
On/C On/C	0.
8 y	Y 8.
2 5 r	R 25.
θ	∠Ø 18.66292°
	(18.7°)

Trig Examples *(Cont'd)*

Example 3 — Tan A:

Find the length of the transition for a 20° angle:

Side a = 18 Inches
Side b = unknown



a) Longhand Method: Use Tan = Opposite/Adjacent

KEYSTROKE	DISPLAY
1. First solve for Tan 20° to find ratio, then enter in Memory:	
On/C On/C	0.
2 0 Tan M+	M+ 0.36397 M
2. Solve for Side b by dividing Side a by stored ratio:	
1 8 ÷ Rcl M+ =	49.45459 M *(49.5 inches)*
3. Clear Memory and clear display:	
Rcl Rcl On/C	0.

b) Use Pythagorean Theorem Keys:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 8 y	Y 18.
2 0 θ	∠Ø 20.°
x	X 49.45459 *(49.5 inches)*

Converting Pitch to Angle/Tangent

Find the angle and corresponding Tangent for a roof with an 8/12 Pitch:

KEYSTROKE	DISPLAY
1. Enter Pitch:	
On/C On/C	0.
8 Inch θ	PTCH 8 INCH
2. Convert Pitch to degrees:	
θ	∠Ø 33.69007°
3. Find Tangent or slope:	
θ θ	0.666667

D:M:S EXAMPLE

Converting Degrees:Minutes:Seconds

Convert 23°42’39” to Decimal Degrees:

KEYSTROKE	DISPLAY
On/C On/C	0.
2 3 • 4 2 • 3 9	DMS 23.42.39
Conv • *(degrees)*	23.71083°

Convert 44.29° to degrees:minutes:seconds format:

KEYSTROKE	DISPLAY
On/C On/C	0.
4 4 • 2 9 Conv • *(d:m:s)*	DMS 44.17.24

Note: Improperly formatted entries will be redisplayed in the correct convention after any operator key is pressed. For example, 30°89’ entered will be corrected and displayed as 31°29’ 0” or 31.48333°.

VELOCITY PRESSURE / VELOCITY EXAMPLES

The Velocity Pressure/Velocity function uses an entered value to calculate these four values:

1. Velocity (FPM)	Number entered is assumed to be Velocity Pressure
2. Velocity (Pressure)	Number entered is assumed to be Velocity (FPM)
3. Metric Velocity (MPS)	Number entered is assumed to be Metric Velocity Pressure (kPA)
4. Metric Velocity Pressure (kPA)	Number entered is assumed to be Metric Velocity (MPS)

The first time you perform this function, the values are displayed in the order identified above. Subsequent calculations begin with the last displayed value.

Converting Velocity Pressure to FPM

After obtaining Velocity Pressures (VP) from taking a traverse, your calculator easily converts to Feet per Minute (FPM).

For example, convert the following VPs to FPM:

0.049”
0.123”
0.027”

KEYSTROKE	DISPLAY
1. Enter first VP and convert to FPM:	
On/C On/C	**0.**
• 0 4 9 Conv 0*	**FPM 886.5445**
2. Enter second VP and convert to FPM:	
• 1 2 3 Conv 0	**FPM 1404.608**
3. Enter third VP and convert to FPM:	
• 0 2 7 Conv 0	**FPM 658.0887**

**The VP◄►FPM function begins with the last displayed value. If FPM is not displayed with the first press of Conv 0, continue pressing 0 until FPM is displayed.*

Converting FPM to Velocity Pressure

Calculate the Velocity Pressure (Imperial and Metric) if the FPM is 500:

KEYSTROKE	DISPLAY
1. Enter 500 FPM to calculate Velocity:	
On/C On/C	**0.**
5 0 0 Conv 0	**FPM 89554.52**
2. Calculate Velocity Pressure (VP):	
0*	**VP 0.015586**
3. Calculate Metric Velocity (MPS):	
0	**MPS 29.06888**
4. Calculate Metric Velocity Pressure (KPA):	
0	**KPA 147928.99**
5. Re-display entered value:	
0	**500.**

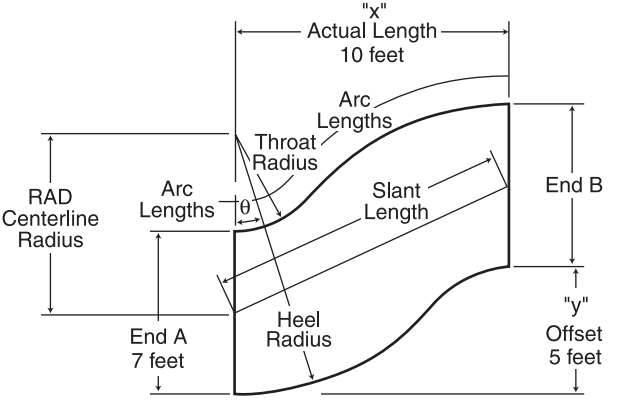
**The VP◄►FPM function begins with the last displayed value. If FPM is not displayed with the first press of Conv 0, continue pressing 0 until FPM is displayed.*

Note: The entered value is used to calculate all four values; for calculation of Velocity (FPM), the entered value is assumed to be VP, and for calculation of VP, the entered value is assumed to be FPM. For calculation of MPS, the entry is assumed to be kPA, and for calculation of kPA, the entry is assumed to be MPS.

OFFSET EXAMPLES

Offset, Basic Example

If an offset is 5 Feet, the actual Length 10 Feet, and the Height of the "end A" equal to 7 Feet, calculate the Centerline Radius, Wrapper Length, Heel Radius, Throat Radius, and Theta.

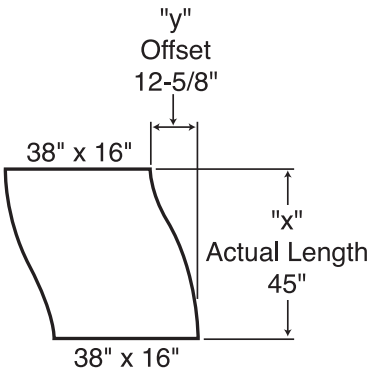


KEYSTROKE	DISPLAY
1. Enter actual Length as "x":	
On/C On/C	0.
1 0 Feet x	X 10 FEET 0 INCH
2. Enter offset Length as "y":	
5 Feet y	Y 5 FEET 0 INCH
3. Enter Height of "end A" as "a":	
7 Feet Conv 4	A STORED 7 FEET 0 INCH
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	RAD 6 FEET 3 INCH
(	WL 11 FEET 7-1/8 INCH
(	HEEL 9 FEET 9 INCH
(	THRT 2 FEET 9 INCH
(	THET 26.56505°

Note: If the calculated Throat Radius is less than zero, an error will be displayed (i.e. "THRT Error") when attempting to calculate the Offset.

OGEE Offset in Feet-Inch-Fractions

If an offset is 12-5/8 Inches, the actual Length 45 Inches, and the Height of the “end A” is 38 Inches, calculate the Centerline Radius, Wrapper Length, Heel Radius, Throat Radius, and Theta.

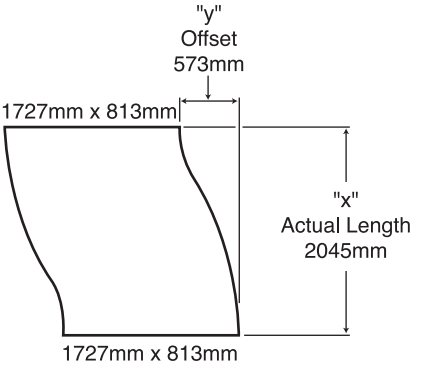


KEYSTROKE	DISPLAY
1. Enter actual Length as “x”:	
On/C On/C	**0.**
4 5 Inch x	**X 45 INCH**
2. Enter offset Length as “y”:	
1 2 Inch 5 / 8 y	**Y 12-5/8 INCH**
3. Enter Height of “end A” as “a”:	
3 8 Inch Conv 4	**A STORED 38 INCH**
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	**RAD 43-1/4 INCH**
(	**WL 47-5/16 INCH**
(	**HEEL 62-1/4 INCH**
(	**THRT 24-1/4 INCH**
(	**THET 15.67176°**

OGEE Offset, in Millimeters

If an offset is 573 Millimeters (mm), the actual Length 2045 mm, and the Height of the "end A" 1727 mm, calculate the Centerline Radius, Wrapper Length, Heel Radius, Throat Radius, and Theta.

**Note*: *To save keystrokes, you do not have to label entries in mm.*



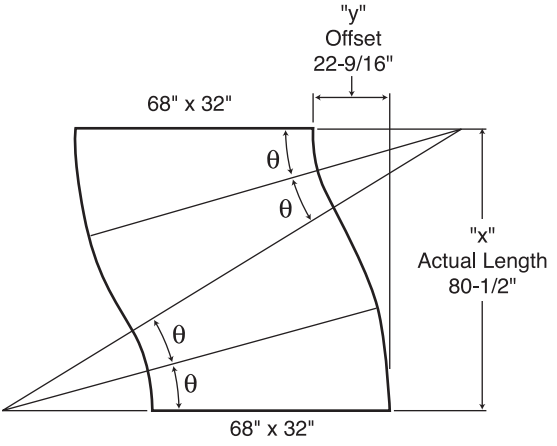
KEYSTROKE	DISPLAY
1. Enter actual Length as "x":	
On/C On/C	0.
2 0 4 5 Conv m x	X 2045. MM
2. Enter offset Length as "y":	
5 7 3 Conv m y	Y 573. MM
3. Enter Height of "end A" as "a":	
1 7 2 7 Conv m Conv 4	A STORED 1727. MM
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	RAD 1967.868 MM *(1968 MM)*
(	WL 2150.408 MM *(2150 MM)*
(	HEEL 2831.368 MM *(2831 MM)*
(	THRT 1104.368 MM *(1104 MM)*
(	THET 15.65264°

Dividing Offset into Multiple Degreed Elbows for Manageable Sections

Solve the offset using the given variables:

Actual Length “x”: 80-1/2 Inches
Offset Length “y”: 22-9/16 Inches
A: 68 inches

Then, divide Theta into four degreed elbows; double Theta for two equal elbows.



KEYSTROKE	DISPLAY
1. Enter actual Length as “x”:	
On/C On/C	0.
8 0 Inch 1 / 2 x	X 80-1/2 INCH
2. Enter offset Length as “y”:	
2 2 Inch 9 / 1 6 y	Y 22-9/16 INCH
3. Enter Height of “way end A” as “a”:	
6 8 Inch Conv 4	A STORED 68 INCH

(Cont’d)

(Cont'd)

KEYSTROKE	DISPLAY
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	**RAD 77-7/16 INCH**
(	**WL 84-5/8 INCH**
(	**HEEL 111-7/16 INCH**
(	**THRT 43-7/16 INCH**
(	**THET 15.6571°**
*5. Convert Theta to degrees:minutes:seconds:**	
Conv •	**DMS 15.39.25**
*6. Multiply by two to double offset:***	
× 2 =	**DMS 31.18.51**

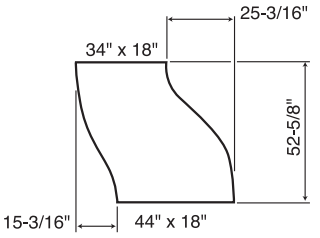
**The angle of Theta can be used to divide the offset into degreed elbows for more manageable sections. If the angle calculated is used, there would be four (4) elbows each at 15°39'25".*

***If two (2) elbows were desired, the calculated angle can be doubled (each elbow would be 31°18'51"). Doubling Theta provides the maximum elbow size for this offset and radius combination. The total angle on either side of center can be divided into as many elbows as is required to make the offset manageable. In the case above, the maximum angle that can be divided is 31°18'51".*

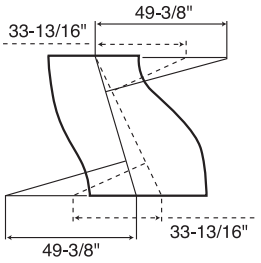
Change OGEE Offset

Solve the Change OGEE Offset below, with Wrapper Size transitions from one end to another.

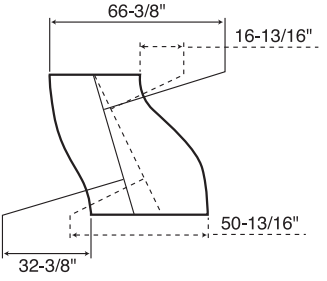
A) Solve Using:
- a. Actual Length “x”: 52-5/8 Inches
- b. Offset “y”: 15-3/16 Inches
- c. End “a”: 34 Inches



Centerline Layout "RAD"



Radii Measured from Heel and THRT



KEYSTROKE	DISPLAY
1. Enter actual Length as “x”:	
On/C On/C	0.
5 2 Inch 5 / 8 x	X 52-5/8 INCH
2. Enter offset Length as “y”:	
1 5 Inch 3 / 1 6 y	Y 15-3/16 INCH
3. Enter Height of “way end A” as “a”:	
3 4 Inch Conv 4	A STORED 34 INCH
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	RAD 49-3/8 INCH
(	WL 55-1/2 INCH
(	HEEL 66-3/8 INCH
(	THRT 32-3/8 INCH
(	THET 16.09806°

B) Solve Using:
a. Actual Length “x”: 52-5/8 Inches
b. Offset “y”: 25-3/16 Inches
c. End “a”: 34 Inches

KEYSTROKE	DISPLAY
1. Enter actual Length as “x”:	
On/C On/C	**0.**
5 2 Inch 5 / 8 x	**X 52-5/8 INCH**
2. Enter offset Length as “y”:	
2 5 Inch 3 / 1 6 y	**Y 25-3/16 INCH**
3. Enter Height of “end A” as “a”:	
3 4 Inch Conv 4	**A STORED 34 INCH**
4. Calculate Centerline Radius, Wrapper Length, Heel Radius, Throat Radius and Theta:	
Conv (	**RAD 33-13/16 INCH**
(	**WL 60-5/16 INCH**
(	**HEEL 50-13/16 INCH**
(	**THRT 16-13/16 INCH**
(	**THET 25.57682°**

“WL”, or the Wrapper, corresponds to the side of the fitting associated with the offset dimension used for the calculation. The longest Wrapper corresponds to the side with the largest offset (y).

Caution: When working with a “Change Transitional OGEE Offset” (Wrapper size transitions from one end to other) **the length of a cheek having a slant length must be adjusted to include that slant length prior to the calculations above taking place.**

LAW OF COSINES EXAMPLES

Field Measuring for Ductwork Using the Law of Cosines — *Introduction*

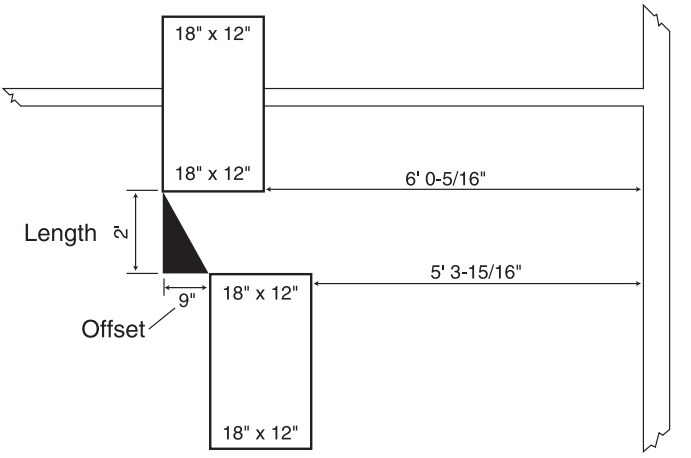
Dimensions taken when measuring objects in the field are taken from the plan or horizontal plane and the elevation or vertical plane of the objects. The purpose is to find the dimensional relationship of distance and alignment between two or more objects. In the Sheet Metal Industry, these specific dimensions are identified as **Length**, **Offset**, and **Angle**.

Relationships can be established between any two objects such as ductwork, structural, penetrations, units or terminal devices. The objects are not as important as an understanding of the information required to achieve the ultimate goal of “the ability to develop the required fittings and/or parts for the system.”

Example:

Two duct lines, both 18 Inches x 12 Inches as shown in the sketch on the next page, are to be measured for a fill-in piece. Measurements of the plan view or horizontal plane are taken from both ducts to a parallel stationary object such as a wall or a structural member. The difference between these two measurements establishes the horizontal offset between the two duct lines, if any exists. The process is repeated for the elevation measurements typically using the floor below the objects (upper at 8 Feet 8 Inches, the lower 8 Feet 10-9/16 Inches). A measurement between the two duct lines will establish length. These measurements and calculations are used to develop the duct and/or fittings required to fill the space.

Using this method we find the fill-in piece will need to be 24 Inches in length with a 9 Inch horizontal offset and a 2-9/16 Inches vertical offset.



Non-90 Degree Triangle Measurement Using Law of Cosines and Heron's Theorem

The Law of Cosines keys calculate the unknown angles after inputting the three known sides of a non-90 degree triangle. Triangle area is also found given the built-in formula for Heron's Theorem.

The relationship of any side to the included angle is identified as the angles opposite the side having the same letter designation (see diagram on next page). When using this method of measuring, the user needs to keep the relationship of the sides to their included angles in perspective at all times. Because your calculator displays all three angles, the user has the discretion of identifying as they choose.

Note: As a test, rotate the letters used to identify the sides and corresponding angles clockwise on the triangle on the next page, input the lengths in the appropriate key location for the new letter and display the included angles. You'll find that the Degree of Angles are still in the same location in relationship to the Length of Sides as before, only the letters used to identify those lengths and angles changed positions.

Using the lengths given below designated as Side a, b and c, calculate the corresponding angles A, B and C.

Side a: 38 Feet 5 Inches
Side b: 23 Feet 4-9/16 Inches
Side c: 26 Feet 1-13/16 Inches

(Cont'd)

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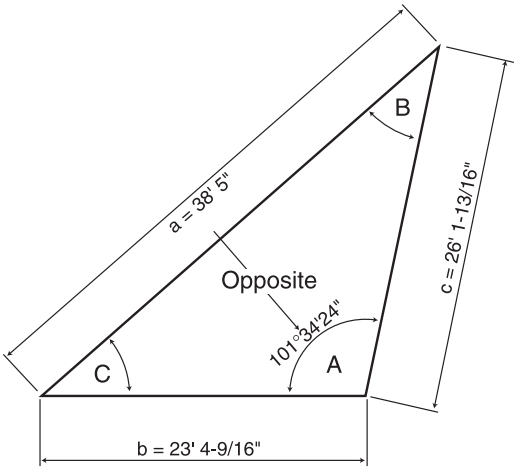


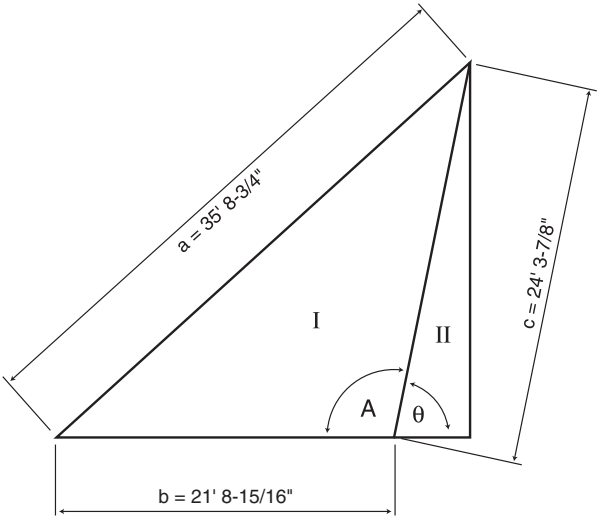
KEYSTROKE	DISPLAY
1. Enter side a, b and c:	
On/C On/C	**0.**
3 8 Feet 5 Inch Conv 4	
	A STORED **38 FEET 5 INCH**
2 3 Feet 4 Inch 9 / 1 6 Conv 5	
	B STORED **23 FEET 4-9/16 INCH**
2 6 Feet 1 Inch 1 3 / 1 6 Conv 6	
	C STORED **26 FEET 1-13/16 INCH**
2. Calculate Angle A, B and C:	
Conv 9	**∠A 101.5734°**
9	**∠B 36.59978°**
9	**∠C 41.8268°**
3. Calculate Triangle area:	
9	**AREA 299.4929 SQ FEET**

Using Law of Cosines and Pythagorean Theorem to Calculate Offset, Length, and Angle

In field measuring, Offset, Length and Angle are the essential dimensions to the design and fabrication of the components required to fill in between objects. In some cases, no structural objects are within reach or parallel to the objects to be measured, so other methods of measuring are required. **In this method, a Triangle is formed to establish the relationship between the objects.** For the sake of identification, this Triangle, which is physically measured, will be called "**The Measured Triangle**," or Triangle "**I**" below, with given dimensions. **Length and Offset form a Right Angle to each other**, so Triangle "**II**", **a Right Triangle**, is used to calculate these dimensions.

*Note: "x" or "y" can represent either Offset or Length, the order dictated by the initial setup and perspective. In the setup, placement of the Right Triangle should always allow for the angle of "θ" in Triangle "**II**" to be established by simple subtraction of angle "**A**°" from a known angle like 180°, as in the example below.*

Find Theta θ, "x," and "y," if the sides of the Measured Triangle "I" are: 35 Feet 8-3/4 Inches, 21 Feet 8-15/16 Inches, and 24 Feet 3-7/8 Inches. See diagram below.



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KEYSTROKE	DISPLAY

1. Enter side a, b and c:

On/C On/C	**0.**
3 5 Feet 8 Inch 3 / 4 Conv 4 A	STORED **35 FEET 8-3/4 INCH**
2 1 Feet 8 Inch 1 5 / 1 6 Conv 5 B	STORED **21 FEET 8-15/16 INCH**
2 4 Feet 3 Inch 7 / 8 Conv 6 C	STORED **24 FEET 3-7/8 INCH**

2. Calculate and input Theta by subtracting Angle "A" (found by the Law of Cosines) from known angle of 180°:

1 8 0 − Conv 9	**∠A 101.5687°**
=	**78.43128** *(Theta θ)*
θ	**∠Ø 78.43128°**

3. Recall stored "c" and input as "r" the Hypotenuse:

Rcl 6 = r	**R 24 FEET 3-7/8 INCH**

4. Calculate "x":

x	**X 4 FEET 10-9/16 INCH**

5. Calculate "y":

y	**Y 23 FEET 9-15/16 INCH**

Sheet Metal Panels for an Irregular Hip Roof

A contractor is going to cover one end of an Irregular Hip Roof with sheet metal panels. The length of the roof along the eave is 98 Feet 5-1/4 Inches, the length along the left hip is 38 Feet 10-11/16 Inches, and the length along the right hip is 73 Feet 1-1/8 Inches. Find the angles between the roof edges.

KEYSTROKE	DISPLAY

1. Enter lengths:

9 8 Feet 5 Inch 1 / 4 Conv 4 A	STORED **98 FEET 5-1/4 INCH**
3 8 Feet 1 0 Inch 1 1 / 1 6 Conv 5 B	STORED **38 FEET 10-11/16 INCH**
7 3 Feet 1 Inch 1 / 8 Conv 6 C	STORED **73 FEET 1-1/8 INCH**

2. Calculate the angles between the roof edges:

Conv 9	**∠A 119.9081°**
9	**∠B 20.02713°**
9	**∠C 40.06473°**
9	**AREA 1232.046 SQ FEET**

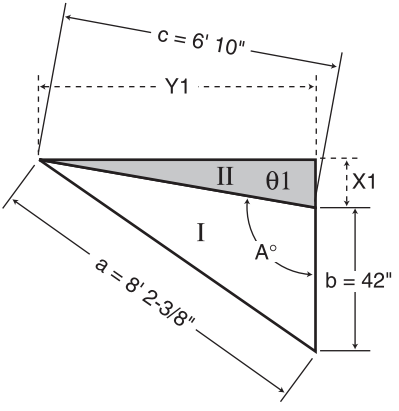
Inline Duct, Single Offset (Computing Offset, Length, and Angle)

When working with the process of direct measure between two ducts #1 and #2, as diagramed below, one leg of "The Measured Triangle" "**I**" should **use the larger horizontal dimension** of the two ducts. Therefore, in this scenario, the 42 Inches dimension of duct #2 is used since it is the larger of the two ducts.

To calculate the angle A^0 in "The Measured Triangle" "**I**" and the dimensions of θ1, X1, and Y1 in triangle "**II**," follow the sequence of input given below to solve for the dimensions in question.

*Note: "x" or "y" can represent either Offset or Length, the order dictated by the initial setup and perspective. In the setup, placement of the Right-Triangle should always allow for the angle of "θ" in triangle "**II**" to be established by simple subtraction of angle "**A°**" from a known angle like 180°, as in the example below.*

Find Theta θ, "x", and "y" if the sides of the Measured Triangle "I" are: 8 Feet 2-3/8 Inches, 42 Inches, and 6 Feet 10 Inches. See diagram below.



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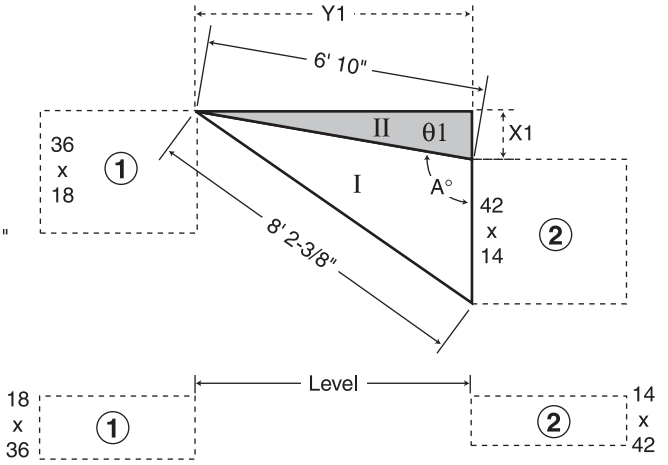
(Cont'd)



KEYSTROKE **DISPLAY**

1. Enter side a, b, and c:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
8 Feet 2 Inch 3 / 8 Conv 4	**A** STORED **8 FEET 2-3/8 INCH**
4 2 Inch Conv 5	**B** STORED **42 INCH**
6 Feet 1 0 Inch Conv 6	**C** STORED **6 FEET 10 INCH**

2. Calculate and input Theta by subtracting Degree "A" (found by the Law of Cosines) from known angle of 180°:

KEYSTROKE	DISPLAY
1 8 0 − Conv 9	**∠A 99.94554°**
=	**80.05446** *(Theta θ)*
θ	**∠Ø 80.05446°**

3. Recall stored "c" and input as "r":

KEYSTROKE	DISPLAY
Rcl 6 = r	**R 6 FEET 10 INCH**

4. Calculate "x":

KEYSTROKE	DISPLAY
x	**X 1 FEET 2-3/16 INCH**

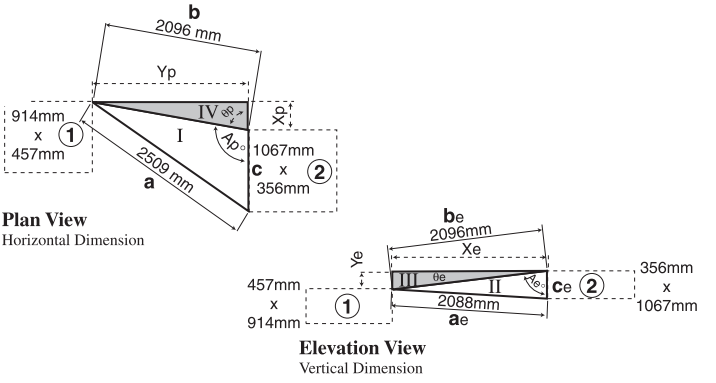
5. Calculate "y":

KEYSTROKE	DISPLAY
y	**Y 6 FEET 8-3/4 INCH**

Inline Duct, Double Offset (Computing Offset, Length and Angle)

This example (see diagrams below) depicts two ducts offsetting both in the horizontal and vertical planes. Basic procedures are the same as those followed in the previous example, except **a correction to the calculated length will be required** at triangle "**V**".

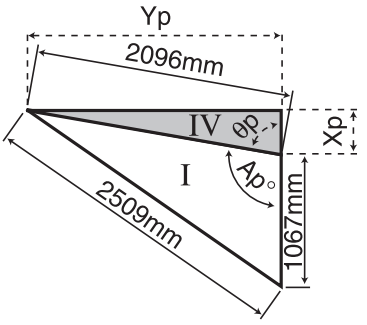
A) Input "Measured Triangle I" to find Triangle IV:



KEYSTROKE	DISPLAY
1. Enter side a, b, and c:	
On/C On/C	**0.**
2 5 0 9 Conv m Conv 4	**A** STORED **2509. MM**
2 0 9 6 Conv m Conv 5	**B** STORED **2096. MM**
1 0 6 7 Conv m Conv 6	**C** STORED **1067. MM**
2. Calculate and input Theta by subtracting Degree "A" (found by the Law of Cosines) from known angle of 180°:	
1 8 0 − Conv 9	**∠A 99.82668°**
=	**80.17332** *(Theta θ)*
θ	**∠Ø 80.17332°**
3. Recall stored "b" and input as "r":*	
Rcl 5 = r	**R 2096. MM**
4. Calculate "x":	
x	**X 357.7207 MM**
5. Calculate "y":	
y	**Y 2065.249 MM**

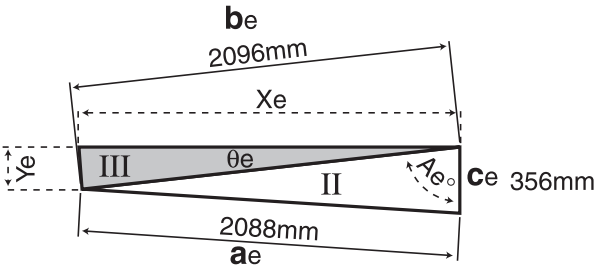
**The calculated dimension of "Yp" is a slant length on the same plane as line "b" in the elevation view. The actual length is found by forming a Right Triangle (see Triangle V).*

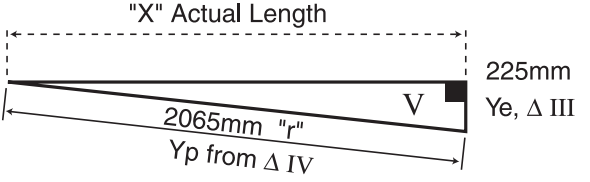
B) Input “Measured Triangle II” to find Triangle III:



KEYSTROKE	DISPLAY
1. Enter side a, b, and c:	
On/C On/C	**0.**
2 0 8 8 Conv m Conv 4	**A** STORED **2088.** MM
2 0 9 6 Conv m Conv 5	**B** STORED **2096.** MM
3 5 6 Conv m Conv 6	**C** STORED **356.** MM
2. Calculate and input Theta by subtracting Degree “A” (found by the Law of Cosines) from known angle of 90° (in this case, the Triangles form a Right Triangle):	
9 0 − Conv 9	**∠A 83.83727°**
=	**6.162732** *(Theta θ)*
θ	**∠Ø 6.162732°**
3. Recall stored “b” and input as “r”:	
Rcl 5 = r	**R 2096.** MM
4. Calculate “x”:	
x	**X 2083.887** MM
5. Calculate “y”:	
y	**Y 225.0112** MM

C) Input Triangle V to Find Actual Length Between the Objects:





KEYSTROKE **DISPLAY**

1. Enter "y" from Triangle IV and enter as "r" (the Hypotenuse):

On/C On/C **0.**

2 0 6 5 Conv m r **R 2065. MM**

2. Enter "y" from Triangle III and enter as "y":

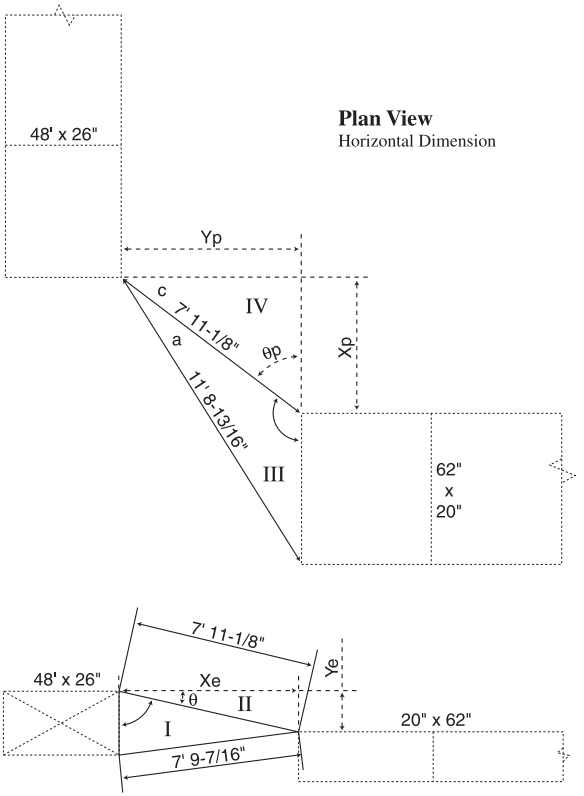
2 2 5 Conv m y **Y 225. MM**

3. Calculate "x" for the Actual Length between the objects:

x **X 2052.706 MM**

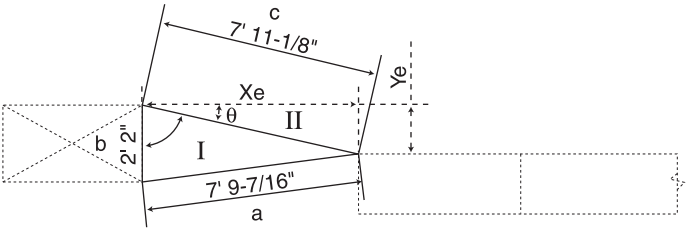
Objects at Right Angles

When you are working with objects at Right Angles, set up the "Measured Triangles" and subsequent calculations in the same manner as the previous inline objects. Due to the vertical misalignment of the two ducts, the added step of **finding the actual length will be required.**



With the exception of the duct dimensions the measured lengths of Triangle III are slant lengths. Therefore, if the calculations are processed using these dimensions the results would also be slant lengths. To find the actual lengths for "Yp" and "Xp" requires the erection of two true length Triangles. The true length Triangles will utilize "Ye" from the elevation offset as the "Y" leg of both triangles and the measured lengths of "a" and "c" as the "r" legs.

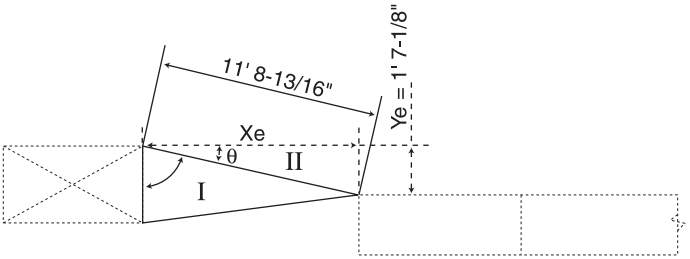
1) Find the elevation offset “Ye” and the actual length “Xe” in D1:



D1 — Elevation View
Vertical Dimension

KEYSTROKE	DISPLAY
1. Enter sides a, b, and c:	
On/C On/C	**0.**
7 Feet 9 Inch 7 / 1 6 Conv 4	**A** STORED **7 FEET 9-7/16 INCH**
2 Feet 2 Inch Conv 5	**B** STORED **2 FEET 2 INCH**
7 Feet 1 1 Inch 1 / 8 Conv 6	**C** STORED **7 FEET 11-1/8 INCH**
2. Calculate and input Theta by subtracting Degree “A” (found by the Law of Cosines) from Right Angle of 90°:	
9 0 − Conv 9	**∠A 78.40512°**
=	**11.59488**
	(Theta θ)
θ	**∠Ø 11.59488°**
3. Recall stored slant length “c” and input as “r”:	
Rcl 6 = r	**R 7 FEET 11-1/8 INCH**
4. Calculate elevation offset “Ye”:	
y	**Y 1 FEET 7-1/8 INCH**
5. Calculate actual length “Xe”:	
x	**X 7 FEET 9-3/16 INCH**

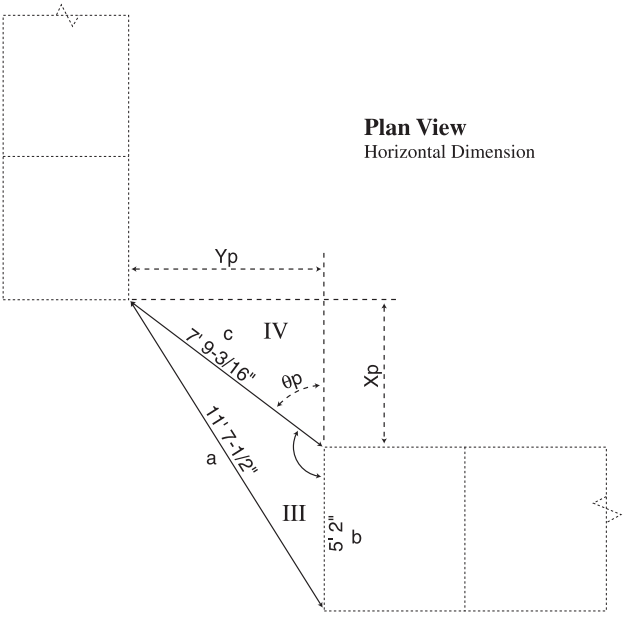
2) Find actual length “Xe” in D2:



D2 — Elevation View
Vertical Dimension

KEYSTROKE	DISPLAY
1. Enter slant length as “r”:	
On/C On/C	0.
1 1 Feet 8 Inch 1 3 / 1 6 r	R 11 FEET 8-13/16 INCH
2. Enter calculated elevation offset from D1 as “y”:	
1 Feet 7 Inch 1 / 8 y	Y 1 FEET 7-1/8 INCH
3. Calculate actual length “Xe” in D2:	
x	X 11 FEET 7-1/2 INCH

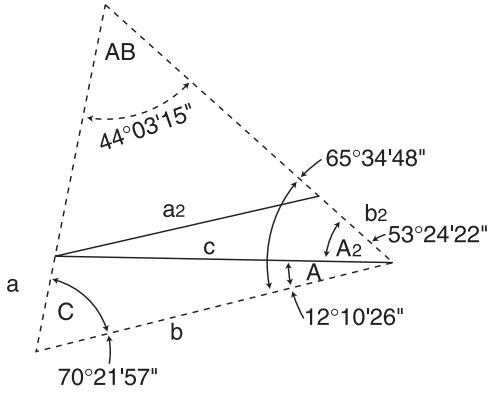
3) Find the horizontal length ”Xp” between the objects and the horizontal offset “Yp” between the objects:



KEYSTROKE	DISPLAY
1. Enter sides a, b and c:	
[On/C] [On/C]	**0.**
[1] [1] [Feet] [7] [Inch] [1] [/] [2] [Conv] [4]	**A** STORED **11 FEET 7-1/2 INCH**
[5] [Feet] [2] [Inch] [Conv] [5]	**B** STORED **5 FEET 2 INCH**
[7] [Feet] [9] [Inch] [3] [/] [1] [6] [Conv] [6]	**C** STORED **7 FEET 9-3/16 INCH**
2. Calculate and input Theta by subtracting Degree “A” (found by the Law of Cosines) from 180°:	
[1] [8] [0] [−] [Conv] [9]	**∠A 126.8649°**
[=]	**53.13512**
	(Theta θ)
[θ]	**∠Ø 53.13512°**
3. Recall stored “c” and input as “r”:	
[Rcl] [6] [=] [r]	**R 7 FEET 9-3/16 INCH**
4. Calculate horizontal length “Xp” between the objects:	
[x]	**X 4 FEET 7-7/8 INCH**
5. Calculate horizontal offset “Yp” between the objects:	
[y]	**Y 6 FEET 2-9/16 INCH**

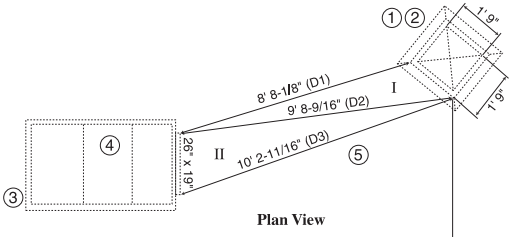
Calculating Angles Between Objects (“Angle Between”)

The Triangle, having a total of 180°, is the basic logic used to solve for the angle between two objects. To accomplish this task, two measurable Triangles are established between the objects for the purpose of finding the angles C, A, and A2, as indicated in the example below. Subtracting the sum of Angles C, A, and A2 from 180° gives us the “Angle Between” the two objects.

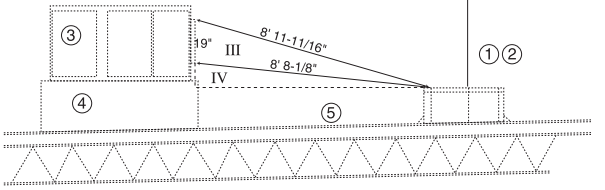


The calculations to solve for the next application are based on the dimensions being **slant lengths** as it would be in any dimensions actually taken in the field. The actual length must be established prior to finding the “Angle Between” (AB).

Calculating Angles Between Objects Example



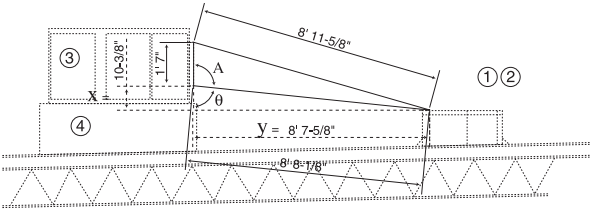
Plan View



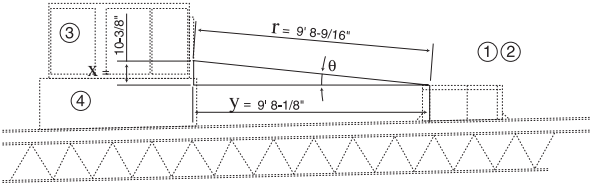
Elevation View

LEGEND

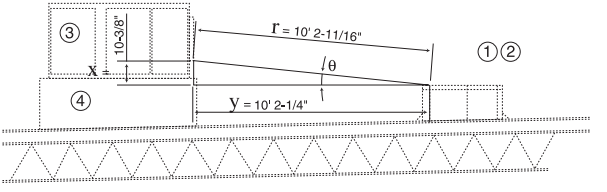
1. Existing Roof Curb to remain.
2. New 20' x 20' duct down through Roof Curb to system below.
3. New Roof Top Furnace with integral curb.
4. Field measure duct required from the existing roof to new Roof Top Furnace.
5. Existing Roof Drain to remain.



D1 — Elevation View

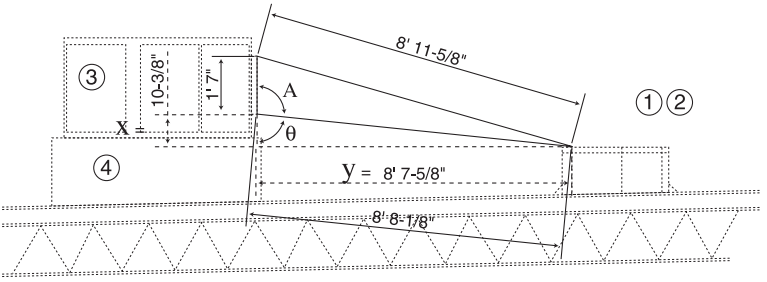


D2 — Elevation View



D3 — Elevation View

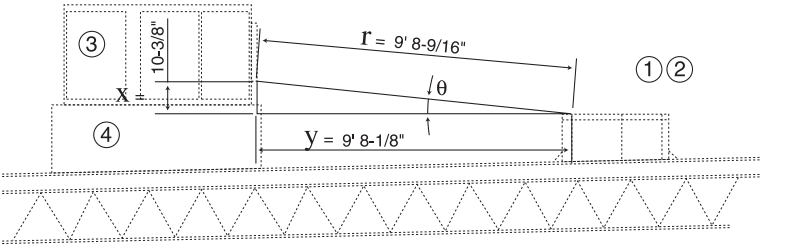
1) Find actual length “y” between objects in D1:



D1 — Elevation View

KEYSTROKE	DISPLAY
1. Enter side a, b, and c:	
On/C On/C	**0.**
8 Feet 1 1 Inch 1 1 / 1 6 Conv 4	**A** STORED **8 FEET 11-11/16 INCH**
1 Feet 7 Inch Conv 5	**B** STORED **1 FEET 7 INCH**
8 Feet 8 Inch 1 / 8 Conv 6	**C** STORED **8 FEET 8-1/8 INCH**
2. Calculate and input Theta by subtracting Degree “A” (found by the Law of Cosines) from known angle of 180°:	
1 8 0 − Conv 9	**∠A 95.70871°**
=	**84.29129** *(Theta θ)*
θ	**∠Ø 84.29129°**
3. Recall stored “c” and input as “r”:	
Rcl 6 = r	**R 8 FEET 8-1/8 INCH**
4. Calculate “x”:	
x	**X 0 FEET 10-3/8 INCH**
5. Calculate “y”, or actual length:	
y	**Y 8 FEET 7-5/8 INCH**

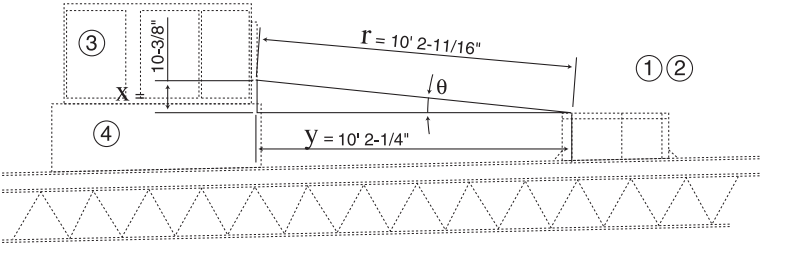
2) Find actual length “y” between objects in D2:



D2 — Elevation View

KEYSTROKE	DISPLAY
1 0 Inch 3 / 8 x	X 10-3/8 INCH
9 Feet 8 Inch 9 / 1 6 r	R 9 FEET 8-9/16 INCH
y	Y 9 FEET 8-1/8 INCH

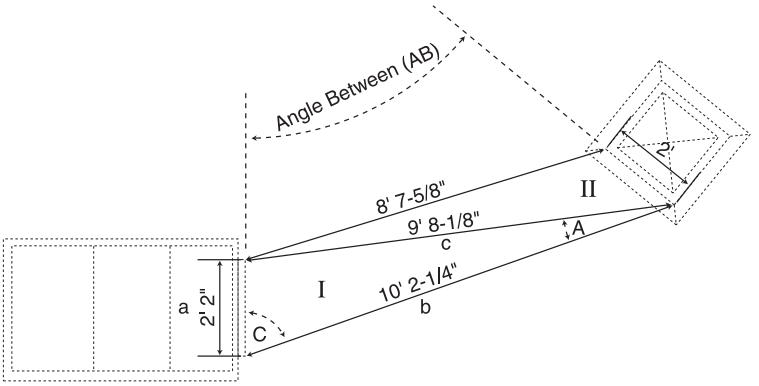
3) Find actual length “y” between objects in D3:



D3 — Elevation View

KEYSTROKE	DISPLAY
1 0 Inch 3 / 8 x	X 10-3/8 INCH
1 0 Feet 2 Inch 1 1 / 1 6 r	R 10 FEET 2-11/16 INCH
y	Y 10 FEET 2-1/4 INCH

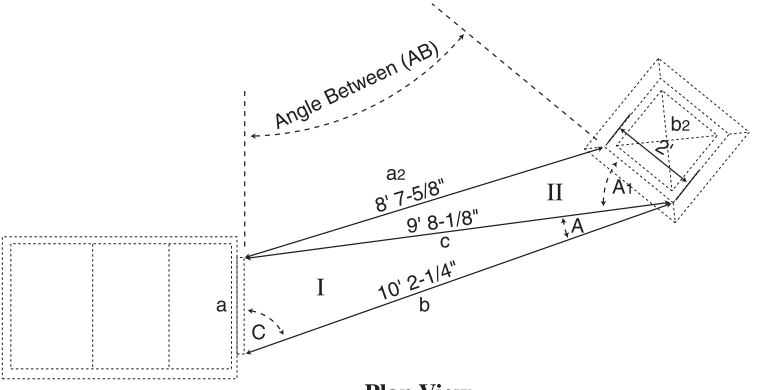
4) Input Triangle I and find Angles A and C:



Plan View

KEYSTROKE	DISPLAY
1. Enter side a, b, and c:	
On/C On/C	**0.**
2 Feet 2 Inch Conv 4	**A STORED 2 FEET 2 INCH**
1 0 Feet 2 Inch 1 / 4 Conv 5	**B STORED 10 FEET 2-1/4 INCH**
9 Feet 8 Inch 1 / 8 Conv 6	**C STORED 9 FEET 8-1/8 INCH**
2. Use Law of Cosines to find Angle "A" and store in Memory 1:	
Conv 9	**∠A 12.17384°**
= Conv 1	**M-1 12.17384°**
3. Use Law of Cosines to find Angle "C" and store in Memory 2:	
Conv 9 9 9	**∠C 70.36573°**
= Conv 2	**M-2 70.36573°**

5) Input Triangle II and find Angle A1 and the “Angle Between”:



Plan View

KEYSTROKE	DISPLAY
1. Enter side a2, b2, and recall c (“a2” was calculated as “y” in first section; “c” is already stored):	
[On/C]	**0.**
[8] [Feet] [7] [Inch] [5] [/] [8] [Conv] [4]	**A STORED 8 FEET 7-5/8 INCH**
[2] [Feet] [Conv] [5]	**B STORED 2 FEET 0 INCH**
[Rcl] [6]	**C STORED 9 FEET 8-1/8 INCH**
2. Use Law of Cosines to find Angle “A2” and store in Memory 3:	
[Conv] [9]	**∠A 53.40618°**
[=] [Conv] [3]	**M-3 53.40618°**
3. Recall M1, M2, and M3 and find total:	
[Rcl] [1] [+] [Rcl] [2] [+] [Rcl] [3] [=]	**135.9458°**
4. Add total to M+ (regular Memory):	
[M+]	**M+ 135.9458° M**
5. Subtract above angle from known angle of 180° to find the Angle Between objects (AB):	
[1] [8] [0] [−] [Rcl] [M+] [=]	**44.05425 M**
6. Convert to degrees:minutes:seconds:	
[Conv] [•]	**DMS 44.03.15 M**
7. Clear Memory and clear display:	
[Rcl] [Rcl] [On/C]	**0.**

FAN LAW EXAMPLES

Fan Law 1

The formula for Fan Law 1 (built into this calculator) is:

$$\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$$

where,
CFM = Feet^3 per Minute
RPM = Revolutions per Minute

Fan laws use the temporary storage registers a, b, a-new, and b-new. Fan Law 1 calculates using the entry of the three known variables and **Conv** **x** to calculate the unknown fourth value.

Example 1:

A 1,250 CFM fan is running at 750 RPM, but it needs to supply 1,400 CFM. What is the RPM required?

KEYSTROKE	DISPLAY
1. Enter current CFM into "a" old:	
On/C **On/C**	**0.**
1 2 5 0 **Conv** 4	**A STORED 1250.**
2. Enter new CFM into "a-new":	
1 4 0 0 **Conv** 7	**An STORED 1400.**
3. Enter current RPM into "b" old:	
7 5 0 **Conv** 5	**B STORED 750.**
4. Calculate new RPM or "b-new":	
Conv **x**	**RPMn FAN LAW1 840.**

Example 2:

You set up a fan with a VFD for 14,000 CFM running at 855 RPM. You change the RPM to 1050. What is the new CFM?

KEYSTROKE	DISPLAY
1. Enter current CFM into "a" old:	
On/C **On/C**	**0.**
1 4 0 0 0 **Conv** 4	**A STORED 14000.**
2. Enter current RPM into "b" old:	
8 5 5 **Conv** 5	**B STORED 855.**
3. Enter new RPM into "b-new":	
1 0 5 0 **Conv** 8	**Bn STORED 1050.**
4. Calculate new CFM or "a-new":	
Conv **x**	**CFMn FAN LAW1 17192.98**

Fan Law 2

The formula for Fan Law 2 (built into this calculator) is:

$$\frac{CFM_{new}}{CFM_{old}} = \sqrt{\frac{SP_{new}}{SP_{old}}}$$

where,
SP = Static Pressure
CFM = Feet^3 per Minute

Fan laws use the temporary storage registers a, b, a-new, and b-new. Fan Law 2 calculates using the entry of the three known variables and **Conv** **y** to calculate the unknown fourth value.

Example 1:

A fan is producing 15,300 CFM at 3.2" SP. If the fan is adjusted to 14,000 CFM, what will the new SP be?

KEYSTROKE	DISPLAY
1. Enter current CFM into "a" old:	
On/C **On/C**	**0.**
1 **5** **3** **0** **0** **Conv** **4**	**A STORED 15300.**
2. Enter new CFM into "a-new":	
1 **4** **0** **0** **0** **Conv** **7**	**An STORED 14000.**
3. Enter current SP into "b" old:	
3 **•** **2** **Conv** **5**	**B STORED 3.2**
4. Calculate new SP or "b-new":	
Conv **y**	**SPn FAN LAW2 2.679311**

Example 2:

After doing a traverse, you find that the duct has 1850 CFM and a SP of 1.2". You adjust the zone dampers and take a new SP that is 0.83. What is the new CFM?

KEYSTROKE	DISPLAY
1. Enter current CFM into "a" old:	
On/C **On/C**	**0.**
1 **8** **5** **0** **Conv** **4**	**A STORED 1850.**
2. Enter current SP into "b" old:	
1 **•** **2** **Conv** **5**	**B STORED 1.2**
3. Enter new SP into "b-new":	
• **8** **3** **Conv** **8**	**Bn STORED 0.83**
4. Calculate "a-new" or new CFM:	
Conv **y**	**CFMn FAN LAW2 1538.58**

Fan Law 3

The formula for Fan Law 3 (built into this calculator) is:

$$\frac{CFM_{new}}{CFM_{old}} = \sqrt[3]{\frac{BHP_{new}}{BHP_{old}}}$$

where,
BHP = Brake Horsepower
CFM = Feet^3 per Minute

Fan laws use the temporary storage registers a, b, a-new, and b-new. Fan Law 3 calculates using the entry of the three known variables and **Conv** ***r*** to calculate the unknown fourth value.

Example 1:

A fan is running at 15,800 CFM using 6.3 BHP. If the CFM is increased to 20,000 CFM, what is the new BHP?

KEYSTROKE	DISPLAY
1. Enter current CFM into "a" old:	
On/C **On/C**	**0.**
1 5 8 0 0 **Conv** 4	**A STORED 15800.**
2. Enter new CFM into "a-new":	
2 0 0 0 0 **Conv** 7	**An STORED 20000.**
3. Enter current BHP into "b" old:	
6 • 3 **Conv** 5	**B STORED 6.3**
4. Calculate new BHP or "b-new":	
Conv ***r***	**BHPn FAN LAW 3 12.77789**

Example 1 (a):

For the fan above, what is the maximum CFM if a ten HP motor is used?

KEYSTROKE	DISPLAY
1. Clear entered CFM in "a-new":	
0 **Conv** 7	**An STORED 0.**
2. Enter new BHP into "b-new":	
1 0 **Conv** 8	**Bn STORED 10.**
3. Calculate new maximum CFM or "a-new":	
Conv ***r***	**CFMn FAN LAW 3 18430.77**

ARC / CIRCLE EXAMPLES

Arc Length — *Degree and Diameter Known*

Find the Arc length of an 85° portion of a Circle with a 5-Foot Diameter:

KEYSTROKE	DISPLAY
On/C On/C	0.
5 Feet Circ	DIA 5 FEET 0 INCH
8 5 Conv Circ	ARC 85.00°
Circ	ARC 3 FEET 8-1/2 INCH

Arc Length — *Degree and Radius Known*

Find the Arc length of a Circle with a 24-Inch Radius and 77° of Arc (77° of 360° Circle):

KEYSTROKE	DISPLAY
On/C On/C	0.
2 4 Inch Conv θ *(Segment Radius)*	RAD 24 INCH
7 7 Conv Circ	ARC 77.00°
Circ	ARC 32-1/4 INCH

Using ArcK to Calculate an Arc Length

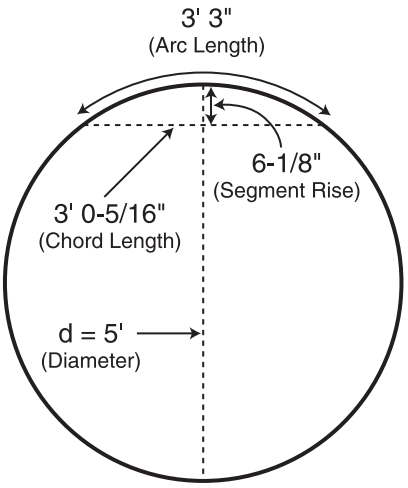
Using the ArcK constant (0.017453), calculate the Arc length given 100° of a one-unit Circle. The Radius is 5 Feet.

KEYSTROKE	DISPLAY
1. Enter Degrees and multiply:	
On/C On/C	0.
1 0 0 ×	100.
2. Enter Radius and multiply:	
5 Feet ×	500 FEET 0 INCH
3. Recall ArcK:	
Conv π	ARCK 0.017453
4. Calculate Arc Length:	
=	8 FEET 8-3/4 INCH

Note: ArcK is equivalent to the constant of a 1° Arc angle for a one-unit value. It may be multipled with a Unitless, Linear, Square or Cubic value. The formula for ArcK is π/180.

Arc Calculations — *Arc Length and Diameter Known*

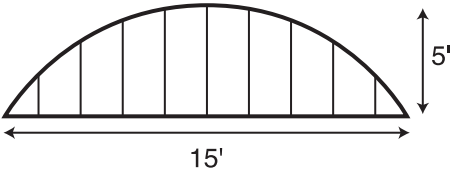
Find the Arc Degree, Chord Length, Rise, Segment and Pie Slice Area, and Segment Rise, given a 5-Foot Diameter and an Arc length of 3 Feet 3 Inches:



KEYSTROKE	DISPLAY
1. Enter Circle Diameter (Note: enter Diameter into the Circ key):	
On/C On/C	**0.**
5 Feet Circ	**DIA 5 FEET 0 INCH**
2. Enter Arc Length:	
3 Feet 3 Inch Conv Circ	**ARC 3 FEET 3 INCH**
3. Find Degree of Arc:	
Circ	**ARC 74.48451°**
4. Find Chord Length:	
Circ	**CORD 3 FEET 0-5/16 INCH**
5. Find Segment Area:	
Circ	**SEG 1.051381 SQ FEET**
6. Find Pie Slice Area:	
Circ	**PIE 4.0625 SQ FEET**
7. Find Segment Rise:	
Circ	**RISE 0 FEET 6-1/8 INCH**

Arched/Circular Rake-Walls — *Chord Length and Segment Rise Known*

You're building a Circular or Arched Rake-Wall. Given a Chord Length of 15 Feet and a Rise of 5 Feet, find all Arc values and lengths of the Arched walls. The On-Center spacing is 16 Inches.



KEYSTROKE	DISPLAY
1. Enter Chord Length and Segment Rise:	
On/C On/C	**0.**
1 5 Feet x	**RUN 15 FEET 0 INCH**
5 Feet y	**RISE 5 FEET 0 INCH**
2. Calculate Radius:	
Conv θ	**RAD 8 FEET 1-1/2 INCH**
3. Find Arc Angle:	
Conv Circ	**ARC 134.76º**
4. Find Arc Length:	
Circ	**ARC 19 FEET 1-5/16 INCH**
5. Display entered Chord Length:	
Circ	**CORD 15 FEET 0 INCH**
6. Find Segment Area:	
Circ	**SEG 54.19722 SQ FEET**
7. Find Pie Slice Area:	
Circ	**PIE 77.63472 SQ FEET**
8. Display entered Segment Rise:	
Circ	**RISE 5 FEET 0 INCH**
9. Display stored On-Center spacing for the wall:	
Circ	**OC 16 INCH***

(Cont'd)

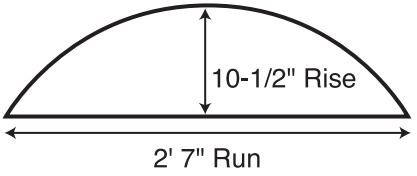
(Cont'd)

KEYSTROKE	DISPLAY
10. Find Arched wall stud lengths:	
Circ	**AW1 4 FEET 10-11/16 INCH**
Circ	**AW2 4 FEET 6-5/8 INCH**
Circ	**AW3 3 FEET 11-3/8 INCH**
Circ	**AW4 3 FEET 0-1/16 INCH**
Circ	**AW5 1 FEET 6-1/4 INCH**

Note: Successive presses of Circ *will toggle to the beginning.*

Arched Windows

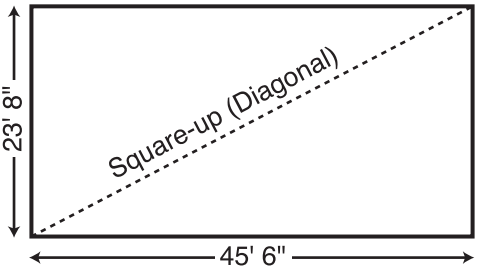
Find the Radius of an Arched window with a Chord Length of 2 Feet 7 Inches and a Rise of 10-1/2 Inches. Then, find the Arc Angle, Arc Length and Segment Area of the window.



KEYSTROKE	DISPLAY
1. Enter Chord Length:	
On/C On/C	**0.**
2 Feet 7 Inch x *(Run)*	**X 2 FEET 7 INCH**
2. Enter Rise:	
1 0 Inch 1 / 2 y *(Rise)*	**Y 10-1/2 INCH**
3. Find Radius:	
Conv θ	**RAD 16-11/16 INCH**
4. Find Arc Angle:	
Conv Circ	**ARC 136.4579°**
5. Find Arc Length:	
Circ	**ARC 39-3/4 INCH**
6. Find Segment Area:	
Circ Circ	**SEG 235.7767 SQ INCH**

Squaring-up a Foundation

A concrete foundation measures 23 Feet 8 Inches by 45 Feet 6 Inches. Find the diagonal measurement (Square-up) to ensure the form is perfectly square.



KEYSTROKE	DISPLAY
1. Enter sides as Rise/Run:	
On/C On/C	**0.**
2 3 Feet 8 Inch y *(Rise)*	**Y 23 FEET 8 INCH**
4 5 Feet 6 Inch x *(Run)*	**X 45 FEET 6 INCH**
2. Find the Square-up (Diagonal):	
r	**R 51 FEET 3-7/16 INCH**

Volume of a Rectangle

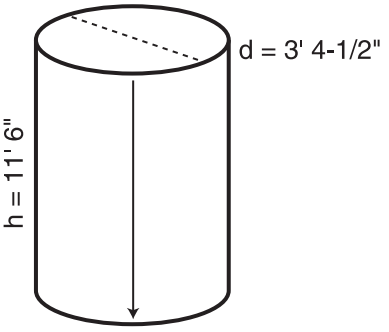
Find the Volume of a Rectangle with the following dimensions: 36 Feet 3 Inches long, by 11 Feet 6 Inches wide, by 4 Inches deep.

KEYSTROKE	DISPLAY
1. Multiply Length by Width:	
On/C On/C	**0.**
3 6 Feet 3 Inch	**36 FEET 3 INCH**
× 1 1 Feet 6 Inch	**11 FEET 6 INCH**
2. Find Area:	
=	**416.875 SQ FEET**
3. Multiply by Depth to find Volume:	
× 4 Inch =	**138.9583 CU FEET**

Volume of Columns

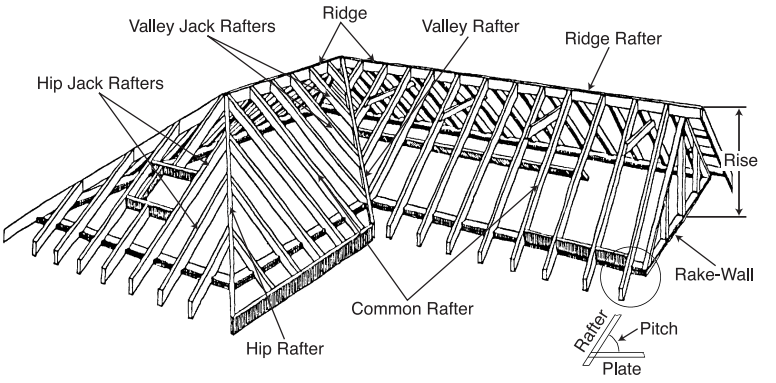
Find the Volume of five (5) Columns, if each has a Diameter of 3 Feet 4-1/2 Inches and a Height of 11 Feet 6 Inches.

Note: Use the Column/Cone function (Conv)).



KEYSTROKE	DISPLAY
1. Find Circle Area:	
On/C On/C	**0.**
3 Feet 4 Inch 1 / 2	**3 FEET 4-1/2 INCH**
Circ Circ Circ	**AREA 8.946176 SQ FEET**
2. Enter Height and find the total Volume for five Columns:	
1 1 Feet 6 Inch y *(Rise)*	**Y 11 FEET 6 INCH**
Conv)	**COL 102.881 CU FEET**
× 5 =	**514.4051 CU FEET**

RIGHT TRIANGLE and ROOF FRAMING EXAMPLES



Roof Framing Definitions

***y* (Rise):** The vertical distance measured from the wall's top plate to the intersection of the pitch line and the center of the ridge.

Span: The horizontal distance or full width between the outside edges of the wall's top plates.

***x* (Run):** The horizontal distance between the outside edge of the wall's top plate and the center of the ridge; in most cases this is equivalent to half of the span.

***θ* (Pitch):** Pitch and Slope are synonymous in modern trade language. Pitch/Slope of a roof is generally expressed in two types of measurement:

1) Ratio of unit Rise to unit Run* — 7/12 or 7 Inch
2) Angle of rafters, in degrees — 30.26°

**Note*: *The unit rise is the number of Inches of Rise per Foot (12 Inches) of unit Run. The unit Run is expressed as one Foot (12 Inches).*

Plate: The top horizontal wall member that the ceiling joist and rafters sit on and fasten to.

Ridge: The uppermost point of two roof planes. This rafter is the uppermost rafter that all Hip, Valley, Valley Jack, and Common rafters are fastened to.

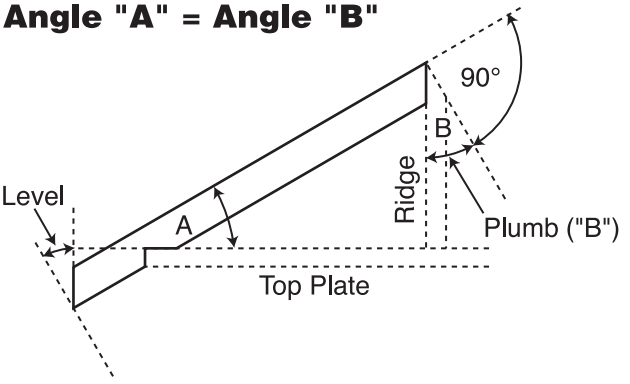
Rafters: Rafters are inclined roof support members. Rafters include the following types:

- **Common Rafter:** The Common connects the plate to the ridge and is perpendicular to the ridge.
- **Hip Rafter:** The Hip rafter extends from the corner of two wall plates to the ridge or King rafter at angle other than 90°. The Hip rafter is an external angle of two planes.
- **Valley Rafter:** The Valley rafter extends from the corner of two wall plates to the ridge or King rafter at angle other than 90°. The Valley rafter is an internal angle of two planes.
- **Jack Rafters:** Rafters that connect the Hip or Valley rafter to the wall plate.
- **Irregular Hip/Valley Jacks:** Jack rafters found in Dual-Pitch or “Irregular” roofs.

Regular Roof: A standard roof where the Hips and/or Valleys run at 45° and have the same Pitch/Slope on both sides of the Hip and/or Valley.

Irregular Roof: A non-standard roof where the Hips and/or Valleys bisect two different Pitches/Slopes, or have “skewed wings” or Irregular Jacks.

Rake-Wall: A gable end wall that follows the Pitch/Slope of a roof.



Plumb: Vertical Cut. The angle of cut from the edge of the board that allows the rafter to mate on the vertical side of the ridge rafter.

Level: Horizontal Cut. The angle of cut from the edge of the board that allows the rafter to seat flat on the wall plate.

Cheek: Side Cut(s). The angle to cut from the SIDE of the Jack rafter to match up against the Hip or Valley rafter, usually made by tilting the blade from 90°. Jack rafters typically have one Cheek cut. If there is only one Pitch (no Irregular Pitch), the angle will be 45°. If there are two Pitches, each side will have a different Cheek cut for the Jack rafter and the angles will total 90°.

Degree of Pitch

If the Degree of Pitch is 30.45°, what is the Percent Grade, Slope and Pitch in Inches?

KEYSTROKE	DISPLAY
On/C On/C	0.
3 0 • 4 5 θ	∠Ø 30.45°
θ	%GRD 58.78702
θ	SLP 0.58787
θ	PTCH 7-1/16 INCH

Note: To convert Pitch in Inches: Simply enter the Pitch in Inches first (e.g., 7 Inch θ), then continuously press the θ key to calculate the Pitch conversions, as above.

Percent Grade

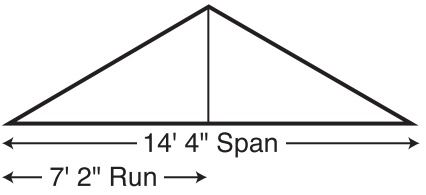
If the Percent Grade is 47.25%, what is the Slope, Pitch in Inches, and Degree of Pitch?

KEYSTROKE	DISPLAY
On/C On/C	0.
4 7 • 2 5 Conv +* θ	%GRD 47.25
θ	SLP 0.4725
θ	PTCH 5-11/16 INCH
θ	∠Ø 25.29073°

**Note: For entering Percent Grade, you need to label the value with the Percent key.*

Common Rafter Length

If a roof has a 7/12 Pitch and a Span of 14 Feet 4 Inches, what is the Point-to-Point length of the Common rafter (excluding the overhang or ridge adjustment)? What are the Plumb and Level cuts?



KEYSTROKE	DISPLAY
1. Find Diagonal or Point-to-Point length of the Common rafter:	
On/C On/C	0.
7 Inch θ	PTCH 7 INCH
1 4 Feet 4 Inch ÷ 2 =	7 FEET 2 INCH
x	X 7 FEET 2 INCH
r	R 8 FEET 3-9/16 INCH
2. Find Plumb and Level cuts:	
r	PLMB 30.25644°
r	LEVL 59.74356°

Common Rafter Length — *Pitch Unknown*

Find the Common rafter length for a roof with a Rise of 6 Feet 11-1/2 Inches and a Run of 14 Feet 6 Inches. Solve for the Pitch in Degrees and in Inches.

KEYSTROKE	DISPLAY
Find Diagonal and Pitch:	
On/C On/C	0.
6 Feet 1 1 Inch 1 / 2 y	Y 6 FEET 11-1/2 INCH
1 4 Feet 6 Inch x	X 14 FEET 6 INCH
r	R 16 FEET 1 INCH
θ	PTCH 5-3/4 INCH
θ	∠Ø 25.63565°

Angle and Diagonal (Hypotenuse)

Find the Diagonal (Hypotenuse) and Degree of Angle of a Right Triangle that is 9 Feet high and 12 Feet long.

KEYSTROKE	DISPLAY
1. Enter Rise and Run:	
On/C On/C	0.
9 Feet y	Y 9 FEET 0 INCH
1 2 Feet x	X 12 FEET 0 INCH
2. Solve for Diagonal/Hypotenuse, Pitch in Inches and Degree of Angle:	
r	R 15 FEET 0 INCH
θ	PTCH 9 INCH
θ	∠Ø 36.8699°

Rise

Find the Rise given a 7/12 Pitch and a Run of 11 Feet 6 Inches.

KEYSTROKE	DISPLAY
On/C On/C	0.
7 Inch θ	PTCH 7 INCH
1 1 Feet 6 Inch x	X 11 FEET 6 INCH
y	Y 6 FEET 8-1/2 INCH

Rise and Diagonal

Find the Rise and Diagonal of a Right Triangle given a 30° Pitch and a Run of 20 Feet 4 Inches.

KEYSTROKE	DISPLAY
On/C On/C	0.
3 0 θ	∠Ø 30.°
2 0 Feet 4 Inch x	X 20 FEET 4 INCH
y	Y 11 FEET 8-7/8 INCH
r	R 23 FEET 5-3/4 INCH

Sheathing Cut

You have framed an equal Pitch roof and need to apply the roof sheathing. Find the distance from the corner of the sheathing so that you can finish the Run at the Hip rafter and cut the material. The Pitch is 6 Inches and you are using 4-Foot by 8-Foot plywood, with the 8-Foot side along the plate.

KEYSTROKE	DISPLAY
1. Enter Pitch:	
On/C On/C	0.
6 Inch θ	PTCH 6 INCH
2. Enter width of plywood:	
4 Feet r	R 4 FEET 0 INCH
3. Find length of sheathing:	
x	X 3 FEET 6-15/16 INCH

Regular Hip/Valley and Jack Rafters

You're working with a 7/12 Pitch, and half your total Span is 8 Feet 5 Inches:

(1) Find Point-to-Point length and cut angles for the Common rafter;
(2) Find the length and cut angles of the adjoining Hip (or Valley) and;
(3) Find the Regular Jack rafter lengths and cut angles (Jack rafters at 16 Inches On-Center spacing).

KEYSTROKE	DISPLAY
1. Find Common rafter length and Plumb and Level cuts:	
On/C On/C	0.
8 Feet 5 Inch x	X 8 FEET 5 INCH
7 Inch θ	PTCH 7 INCH
r	R 9 FEET 8-15/16 INCH
r	PLMB 30.25644°
r	LEVL 59.74356°

(Cont'd)

(Cont'd)

KEYSTROKE	DISPLAY
2. Find Hip/Valley rafter length and cut angles:	
Hip/V	**H/V 12 FEET 10-1/2 INCH**
Hip/V	**PLMB 22.41512°**
Hip/V	**LEVL 67.58488°**
Hip/V	**CHK1 45.°**
3. Find Jack rafter lengths and cut angles:	
Jack	**JKOC 16 INCH***
Jack	**JK1 8 FEET 2-3/8 INCH**
Jack	**JK2 6 FEET 7-7/8 INCH**
Jack	**JK3 5 FEET 1-3/8 INCH**
Jack	**JK4 3 FEET 6-13/16 INCH**
Jack	**JK5 2 FEET 0-5/16 INCH**
Jack	**JK6 0 FEET 5-13/16 INCH**
Jack	**JK7 0 FEET 0 INCH**
Jack	**PLMB 30.25644°**
Jack	**LEVL 59.74356°**
Jack	**CHK1 45.°**

**Note*: *If display does not read JKOC 16 INCH (the default), then enter 16 Inches prior to beginning calculation (e.g.,* 1 6 Inch Jack*).*

Jack Rafters — *Using Other Than 16 Inch On-Center Spacing*

A roof has a 9/12 Pitch and a Run of 6 Feet 9 Inches. Find the Jack rafter lengths and cut angles at 18-Inch (versus 16-Inch) On-Center spacing. The On-Center spacing is used for both Regular and Irregular Jack calculations.

KEYSTROKE	DISPLAY
1. Enter Pitch, Run, and On-Center spacing:	
On/C On/C	0.
9 Inch θ	PTCH 9 INCH
6 Feet 9 Inch x	X 6 FEET 9 INCH
1 8 Inch Jack Jack	JKOC STORED 18 INCH
2. Find Jack rafter lengths and cut angles:	
Jack	JK1 6 FEET 6-3/4 INCH
Jack	JK2 4 FEET 8-1/4 INCH
Jack	JK3 2 FEET 9-3/4 INCH
Jack	JK4 0 FEET 11-1/4 INCH
Jack	JK5 0 FEET 0 INCH
Jack	PLMB 36.8699°
Jack	LEVL 53.1301°
Jack	CHK1 45.°
3. Reset On-Center spacing to 16 Inches:	
1 6 Inch Jack	JKOC 16 INCH

Irregular Hip/Valley and Jack Rafters — *Descending, with On-Center Spacing Maintained*

You're working with a 7/12 Pitch and half your overall Span is 4 Feet. The Irregular Pitch is 8/12, and 16-Inch On-Center spacing is maintained on both sides. Complete the following steps:

(1) Find the length of the Common rafter;
(2) Reset calculator to 16-Inch On-Center spacing;
(3) Enter the Irregular Pitch; find the length of the adjoining "Irregular" Hip (or Valley) and the cut angles;
(4) Find the Jack lengths on the "Irregular" Pitch side (16-Inch On-Center spacing);
(5) Find the cut angles;
(6) Find the Jack lengths on the "Regular" Pitch side (16-Inch On-Center spacing);
(7) Find the cut angles.

KEYSTROKE	DISPLAY
1. Find Common rafter length:	
On/C On/C	0.
7 Inch θ	PTCH 7 INCH
4 Feet x	X 4 FEET 0 INCH
r	R 4 FEET 7-9/16 INCH
2. Enter On-Center spacing:	
1 6 Inch Jack	JKOC 16 INCH
3. Find Irregular Hip/Valley rafter length and cut angles:	
8 Inch Conv Hip/V	IPCH 8 INCH
Hip/V	IH/V 5 FEET 9-11/16 INCH
Hip/V	PLMB 23.70162°
Hip/V	LEVL 66.29838°
Hip/V	CHK1 41.18592°
Hip/V	CHK2 48.81408°
4. Find Irregular Jack lengths:	
Conv Jack	IJOC STORED 16 INCH
Jack*	IJ1 2 FEET 9-5/8 INCH
Jack	IJ2 1 FEET 4-13/16 INCH
Jack	IJ3 0 FEET 0 INCH

**Note*: *It is not necessary to continue pressing* Conv *when displaying each Jack rafter size.*

(Cont'd)

(Cont'd)

KEYSTROKE	DISPLAY

5. Find Irregular Jack Plumb, Level, and Cheek cut angles:

Jack	**PLMB 33.69007°**
Jack	**LEVL 56.30993°**
Jack	**CHK1 41.18592°**

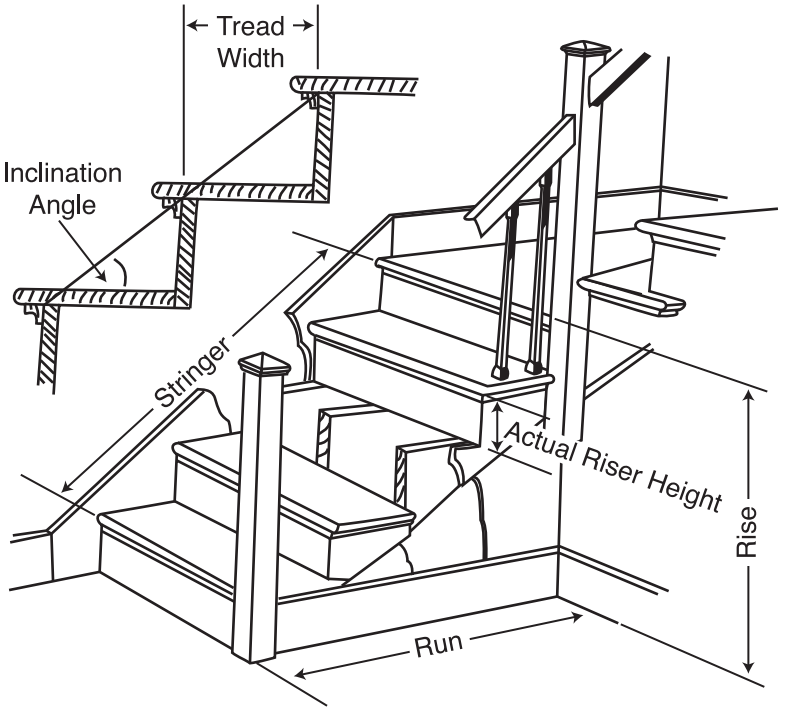
6. Find Regular Jack lengths:

Jack	**JKOC** STORED **16** INCH
Jack	**JK1 2** FEET **10-3/8** INCH
Jack	**JK2 1** FEET **1-1/4** INCH
Jack	**JK3 0** FEET **0** INCH

7. Find Regular Jack Plumb, Level, and Cheek cut angles:

Jack	**PLMB 30.25644°**
Jack	**LEVL 59.74356°**
Jack	**CHK1 48.81408°**

STAIR LAYOUT EXAMPLES



Stair Layout Definitions

***y* (Rise):** The "floor-to-floor" or "landing-to-landing" Rise is the actual vertical Rise required for building a stairway after the finish flooring has been installed.

***x* (Run):** The Run of a stairway is the amount of horizontal space required. The total Run of a stairway is equal to the width of each Tread multiplied by the number of Treads.

Desired Riser Height: The desired Riser height is the amount of vertical Rise you allow for each individual Riser in the stairway. This is sometimes dictated by local code.

Actual Riser Height: The actual height of each Riser is measured from the top of one Tread to the top of the next Tread.

Number of Risers: The number of Risers includes both the first and the last Riser of the stairway.

Riser Overage or Underage: The Riser Overage or Underage is the difference between the "floor-to-floor" Rise and the total height of all of the Risers. Many times the Riser height does not divide evenly into the floor-to-floor Rise and a small fraction of an Inch is left over. A positive remainder is an Overage, while a negative remainder is an Underage.

Tread Width: The width of each Tread is measured from the front of one Riser to the front of the next Riser. The width of each Tread does NOT include the nosing or overhang of the Tread. The nosing or overhang of a Tread is the rounded front of the Tread that projects beyond the face of the Riser.

Number of Treads: The number of Treads is one less than the number of Risers.

Tread Overage or Underage: The Tread Overage or Underage is the difference between the Run or horizontal space that a stairway must fit into and the total width of the Treads. Similar to the Riser Overage/Underage, many times the total width of the Treads does not divide evenly into the Run or horizontal space for the stairway and a small fraction of an Inch is left over. A positive remainder is an Overage, a negative remainder is an Underage.

Stringer: Also called a Carriage, Stair Horse, or Stair Jack. A Stringer is the diagonal member that supports the Treads and Risers.

Angle of Incline: The angle of incline of the stairway is determined by the Rise and Run of each stair. The angle of incline should not be confused with the Pitch of the stairway. The Pitch of a stairway is the angle based on the floor-to-floor Rise and the horizontal Run of the stairway. The angle of incline is based on the "actual" Riser height and the "actual" Tread width of the stair.

Stairwell Opening: The length of the opening at the top of the stairs. The computation is based on the Headroom Height (the desired spacing between the stairs and upper floor ceiling) and thickness of the upper floor where the opening is located.

Stairs — *Given Only Floor-to-Floor Rise*

You're building a stairway with a total Rise of 9 Feet 11 Inches. Your desired Riser height is 7-1/2 Inches and desired Tread width is 10 Inches. The desired Headroom is 6 Feet 8 Inches and Floor Thickness 10 Inches*. Find all stair values, then calculate the Run.

**Note*: *Headroom and Floor Thickness are required to calculate the height of the stairwell opening.*

KEYSTROKE	DISPLAY
1. Enter known Rise:	
On/C On/C	**0.**
9 Feet 1 1 Inch y	**Y 9 FEET 11 INCH**
2. Recall (default) stored "desired" stair Riser height:	
Rcl Stair	**R-HT STORED 7-1/2 INCH**
3. Find Riser height, number of Risers, Riser Overage/Underage, Tread width, number of Treads, Tread Overage/Underage, length of stairwell opening, Stringer length and Angle of Incline. As a final step, calculate the Run:	
Stair	**R-HT 7-7/16 INCH**
Stair	**RSRS 16.**
Stair	**R+/– 0 INCH**
Stair	**T-WD 10 INCH**
Stair	**TRDS 15.**
Stair	**T+/– 0 INCH**
Stair	**OPEN 10 FEET 1 INCH**
Stair	**STRG 15 FEET 6-15/16 INCH**
Stair	**INCL 36.64003°**
Stair	**RUN 12 FEET 6 INCH**
Stair*	**RISE (Y) STORED 9 FEET 11 INCH**

**Continuous presses of* Stair *will also recall stored desired Riser height, Tread, Headroom and Floor Thickness values.*

To Change Desired Riser Height: If you wish to use a desired Riser height of other than 7-1/2 Inches (the calculator's default), simply enter a new value. For example, to enter eight Inches, enter 8 *Inch* Conv *Stair*. Press Rcl *Stair* to review your new entry. This value will be permanently stored until you change it.

To Change Desired Tread Width: If you wish to use a desired Tread width of other than ten Inches (the calculator's default), simply select a new value via the Preference Mode (press Conv, then − four times and use the + or − keys to increase/decrease by 1/4 Inch increments). This value will be permanently stored until you change it.

To Change Desired Headroom: If you wish to use a desired Headroom other than six Feet eight Inches (the calculator's default), simply select a new value via the Preference Mode (press Conv, then − five times and use the + or − keys to increase/decrease by one-Inch increments). See below example. This value will be permanently stored until you change it.

To Change Desired Floor Thickness: If you wish to use a desired Floor Thickness of other than ten Inches (the calculator's default), simply select a new value via the Preference Mode (press Conv, then − six times and use the + or − keys to increase/decrease by one-Inch increments). This value will be permanently stored until you change it.

KEYSTROKE	DISPLAY
1. Select Headroom via Preference Mode:	
On/C *On/C*	**0.**
Conv − − − − −	**HDRM 6 FEET 8 INCH**
2. Decrease Headroom Height by two Inches:	
− −	**HDRM 6 FEET 6 INCH**
3. Then increase Headroom Height by four Inches:	
+ + + +	**HDRM 6 FEET 10 INCH**
4. Return Headroom Height to default of six Feet eight Inches:	
− −	**HDRM 6 FEET 8 INCH**

Stairs — *Given Only the Run*

You're building a stairway with a total Run of 20 Feet. Your desired Riser height is 7-1/2 Inches and desired Tread width is ten Inches (default, or preset values). The desired headroom is 6 Feet 8 Inches and floor thickness 10 Inches (defaults). Find all stair values, then calculate the Rise.

KEYSTROKE	DISPLAY
1. Enter Run:	
On/C On/C	**0.**
2 0 Feet x	**X 20 FEET 0 INCH**
2. Find Riser height, number of Risers, Riser Overage/Underage, Tread width, number of Treads, Tread Overage/Underage, stairwell opening, Stringer length and Angle of Incline. As a final step, calculate the Rise:	
Stair	**R-HT 7-1/2 INCH**
Stair	**RSRS 25.**
Stair	**R+/– 0 INCH**
Stair	**T-WD 10 INCH**
Stair	**TRDS 24.**
Stair	**T+/– 0 INCH**
Stair	**OPEN 10 FEET 0 INCH**
Stair	**STRG 25 FEET 0 INCH**
Stair	**INCL 36.8699°**
Stair	**RUN (x) STORED 20 FEET 0 INCH**
Stair	**RISE 15 FEET 7-1/2 INCH**

Stairs — *Given Rise and Run*

You need to build a stairway with a floor-to-floor height of 10 Feet 1 Inch, a Run of 15 Feet 5 Inches, and a nominal desired Riser height of 7-1/2 Inches (default). Calculate all stair values.

KEYSTROKE	DISPLAY
1. Enter Rise and Run:	
On/C On/C	0.
1 0 Feet 1 Inch y	Y 10 FEET 1 INCH
1 5 Feet 5 Inch x	X 15 FEET 5 INCH
2. Find stair values:	
Stair	R-HT ⚠ 7-9/16 INCH*
Stair	RSRS 16.
Stair	R+/– 0 INCH
Stair	T-WD 12-5/16 INCH
Stair	TRDS 15.
Stair	T+/– – 0-5/16 INCH
Stair	OPEN 12 FEET 2-1/2 INCH
Stair	STRG 18 FEET 0-3/4 INCH
Stair	INCL 31.5588°
Stair	RUN (X) STORED 15 FEET 5 INCH
Stair	RISE (Y) STORED 10 FEET 1 INCH
Stair	R-HT STORED 7-1/2 INCH
Stair	T-WD STORED 10 INCH
Stair	HDRM STORED 6 FEET 8 INCH
Stair	FLOR STORED 10 INCH

**A yield symbol (⚠) will light in the display meaning the calculated Riser height exceeds the stored desired Riser height by 10%.*

Baluster Spacing

You are going to install a handrail at the top of a balcony. Your total Span is 156 Inches and you would like the space between the balusters to be about 4 Inches. If each baluster is 1-1/2 Inches wide, what is the exact spacing between each baluster?

KEYSTROKE	DISPLAY
1. Estimate number of balusters in Span:	
On/C On/C	**0.**
1 5 6 Inch ÷	**156 INCH**
5 Inch 1 / 2 =*	**28.36364** *(28 balusters)*

**desired spacing plus baluster width (4 Inches plus 1-1/2 Inches).*

2. Find total space 'occupied' by the balusters by multiplying the width of each baluster by the rounded number of balusters (found above):

1 Inch 1 / 2 ×	**1-1/2 INCH**
2 8 =	**42 INCH**

3. Find total space between all balusters:

1 5 6 Inch −	**156 INCH**
4 2 Inch =	**114 INCH**

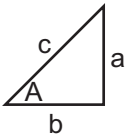
4. Find actual baluster spacing by dividing total space between all balusters by the number of spaces between the balusters (number of balusters plus one equals 29):

1 1 4 Inch ÷	**114 INCH**
2 9 =	**3-15/16 INCH**

APPENDIX A — *TRIGONOMETRY FORMULAS*

The Sine of an angle is the ratio of the opposite side over the Hypotenuse:

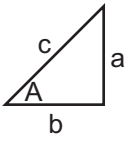
Sine $\text{Sin} = \dfrac{\text{Opposite}}{\text{Hypotenuse}}$



$\sin A = \dfrac{a}{c}$

The Cosine of an angle is the ratio of the adjacent side over the Hypotenuse:

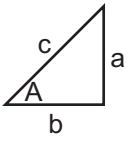
Cosine $\text{Cos} = \dfrac{\text{Adjacent}}{\text{Hypotenuse}}$



$\cos A = \dfrac{b}{c}$

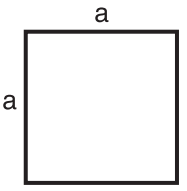
The Tangent of an angle is the ratio of the opposite side over the adjacent side:

Tangent $\text{Tan} = \dfrac{\text{Opposite}}{\text{Adjacent}}$

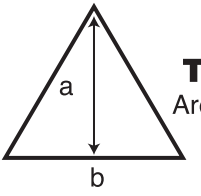


$\tan A = \dfrac{a}{b}$

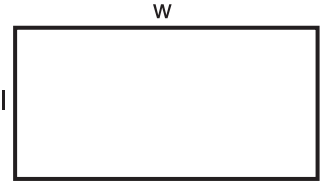
AREA FORMULAS



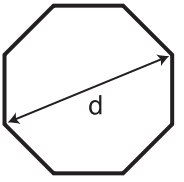
Square
Area = a^2



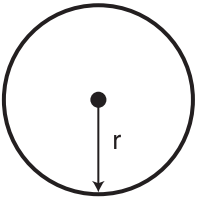
Triangle
Area = 1/2 ab



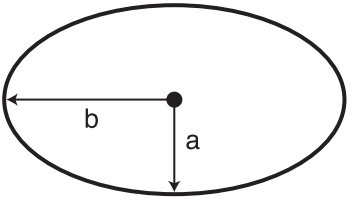
Rectangle
Area = lw



Octagon
Area = $(d/2)^2$ x 2.828

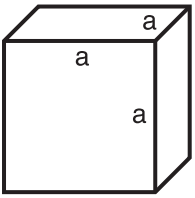


Circle
Circumference = $2\pi r$
Area = πr^2



Ellipse
Area = πab

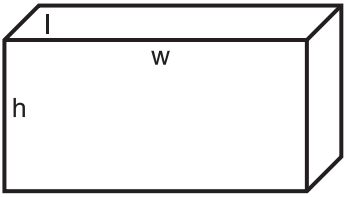
SURFACE AREA / VOLUME FORMULAS



Cube

Surface Area = $6a^2$

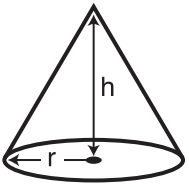
Volume = a^3



Rectangle

Surface Area = $2hw + 2hl + 2lw$

Volume = l x w x h

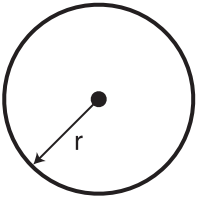


Cone

Surface Area = $\pi r \sqrt{r^2 + h^2}$

(+ πr^2 if you add the base)

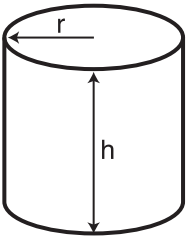
Volume = $\frac{\pi r^2 h}{3}$



Sphere

Surface Area = $4\pi r^2$

Volume = $4/3\pi r^3$



Cylinder

Surface Area = $2\pi rh + 2\pi r^2$

Volume = $\pi r^2 h$

APPENDIX C — *OFFSET FORMULAS*

With Offset = "y" and Length = "x,"

$$\text{SlantLength} = \sqrt{\text{Offset}^2+\text{Length}^2} = \sqrt{x^2+y^2} = r$$

$$\theta = \text{ArcSin}\left(\frac{\text{Offset}}{\text{SlantLength}}\right) = \text{ArcTan}\left(\frac{\text{Offset}}{\text{Length}}\right) = \text{ArcTan}\left(\frac{y}{x}\right)$$

$$\text{CenterlineRadius} = \frac{\text{SlantLength}}{4\text{Sin}(\theta)} = \frac{\text{SlantLength}^2}{4 * \text{Offset}}$$

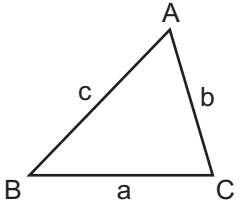
$$\text{WrapperLength (aka StretchOut)} = \text{CenterlineRadius} * \text{ArcK} * 4\theta$$

$$\text{HeelRadius} = \text{CenterlineRadius} + (a \div 2)$$

$$\text{ThroatRadius} = \text{CenterlineRadius} - (a \div 2)$$

APPENDIX D — *LAW OF COSINES / HERON'S THEOREM FORMULAS*

Law of Cosines

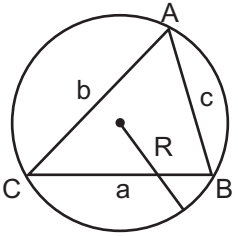


$a^2 = b^2 + c^2 - 2bc\cos A$

$b^2 = c^2 + a^2 - 2ca\cos B$

$c^2 = a^2 + b^2 - 2ab\cos C$

Law of Sines



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$$

Heron's Theorem

$$s = \frac{1}{2}(a + b + c)$$

$$\text{AREA}_{ABC} = \sqrt{s(s-a)(s-b)(s-c)}$$

$$r = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s} = \frac{\text{AREA}_{ABC}}{s}$$

$$\text{Tan}\left(\frac{A}{2}\right) = \frac{r}{s-a} \qquad \text{Tan}\left(\frac{B}{2}\right) = \frac{r}{s-b} \qquad \text{Tan}\left(\frac{C}{2}\right) = \frac{r}{s-c}$$

APPENDIX E — *FAN LAW FORMULAS*

Fan Law 1 Formula

$$\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$$

where,
CFM = Feet^3 per Minute
RPM = Revolutions per Minute

Fan Law 2 Formula

$$\frac{CFM_{new}}{CFM_{old}} = \sqrt{\frac{SP_{new}}{SP_{old}}}$$

where,
SP = Static Pressure
CFM = Feet^3 per Minute

Fan Law 3 Formula

$$\frac{CFM_{new}}{CFM_{old}} = \sqrt[3]{\frac{BHP_{new}}{BHP_{old}}}$$

where,
BHP = Brake Horsepower
CFM = Feet^3 per Minute

APPENDIX F — DEFAULT SETTINGS

After a Full Reset/Clear All, your calculator will return to the following settings:

SETTING	IMPERIAL
On-Center Spacing	16 Inches
Fractional Resolution	1/16
Area Display	Standard
Volume Display	Standard
Desired Riser Height	7-1/2 Inches
Desired Tread Width	10 inches
Stairway Headroom	6 Feet 8 Inches
Floor Thickness (Stairs)	10 Inches
Jack Rafters	Descending
Irregular Jack Spacing	OC-OC
Exponent	On
Meter Linear Rounding	0.000
Degree Rounding	Float
Mathematical Operations	Order of Operations Method

APPENDIX G — PREFERENCE SETTINGS

Your calculator has Preference Settings that allow you to customize or set desired dimensional formats and calculations. See the list of Settings below and instructions how to set them on the following page.

If you replace your batteries or perform a *Full Reset** (press **Off**, hold down ✕, and press **On/C**), your calculator will return to the following settings (in addition to those listed on the previous page):

PREFERENCE	OPTIONS
1) Fractional Resolution	— ***1/16** *(displays fractional values to the nearest 16th of an Inch)* — **1/32** — **1/64** — **1/2** — **1/4** — **1/8**
2) Area Display Format	— ***Standard** *(if units entered are the same — e.g., Feet x Feet — the answer will remain in this format (Square Feet), but if units entered are different — e.g., Inches x Feet — area answer will be displayed in **Square Feet**)* — **Square Feet** *(area answers always displayed in Square Feet, regardless of unit entry — e.g., Inches x Inches = Square Feet)* — **Square Meters** *(area answers always displayed in Square meters — e.g., Feet x Feet = Square Meters)*

(Cont'd)

(Cont'd)

PREFERENCE	OPTIONS
3) Volume Display Format	— ***Standard** *(if units entered are the same — e.g., Feet x Feet x Feet — the answer will remain in this format (Cubic Feet), but if units entered are different — e.g., Feet x Feet x Inches — volume answer will always be displayed in **Cubic Feet**)* — **Cubic Feet** *(volume answers always displayed in Cubic Feet, regardless of unit entry — e.g., Inches x Inches x Inches = Cubic Feet)* — **Cubic Meters** *(volume answers always displayed in Cubic Meters, regardless of unit entry — e.g., Feet x Feet x Feet = Cubic Meters)*
4) Tread Width	— ***10 Inch** *(default)* — Use ⊕ or ⊖ key to increase or decrease above value by increments of 1/4 Inch
5) Stairwell — Headroom Height	— ***6 Feet 8 Inch** *(default)* — Use ⊕ or ⊖ key to increase or decrease above value by increments of 1 Inch
6) Floor Thickness	— ***10 Inch** *(default)* — Use ⊕ or ⊖ key to increase or decrease above value by increments of 1 Inch
7) Jack Rafters Descending or Ascending	— ***Descending** *(Jack rafters are displayed from largest to smallest size)* — **Ascending** *(Jack rafters are displayed from smallest to largest size)*

(Cont'd)

(Cont'd)

PREFERENCE	OPTIONS
8) Irregular Jack Rafters O-C or Mate	— ***OC-OC** *(On-Center spacing maintained on both Regular and Irregular sides)* — **JAC-JAC** *(Regular/Irregular Jack rafters "mate" at the Hip/Valley, i.e., On-Center spacing not maintained on both sides)*
9) Exponent Off or On	— ***On** *(Exponential Mode is On; turns on Auto-Ranging; i.e., if display can't show seven digits, will display in next largest unit)* — **Off** *(Exponential Mode is Off)*
10) Meter Linear Display	— ***0.000** *(Linear Meter answers always displayed to third decimal place)* — **FLOAT** *(Linear Meter answers displayed to the maximum number of decimal points, as entered — e.g., 1.234 Meters + 2.56 Meters = 3.794 Meters)*
11) Degrees Displayed	— ***FLOAT** — **0.00°**
12) Mathematical Operations	— ***Order** *(Order of Operations Method of Calculating)* — **Chain** *(Chain Method)*
13) Fractional Mode	— ***Standard** *(fractions are displayed to the nearest fraction)* — **Constant** *(fractions are displayed in the set fractional resolution)*

How to Set Preferences

The following sections detail Preference Setting options.

Enter the Preference Mode by pressing Conv = *(Prefs)*. Access each category by pressing the = key until you reach the desired setting. *Within each category,* press the + or − keys to toggle between individual selections. Press On/C to exit and set in your Preference.

Note: + will advance, − will back up. Pressing the = key continuously in this mode will revolve the Preference Settings full circle.

You may change these settings at any time by repeating the above, and setting in a new preference. Or, you may review settings by pressing Rcl =.

For example, if you wish to display all your dimensional area answers in Square Meters, press Conv = = *(Area Std)*, then the + key until "**AREA 0. SQ M**" is displayed. Simply exit this mode by pressing On/C or any key, *and all your future area answers will be displayed in Square Meters.*

Accessing Preference Settings

To Set "Fractional Resolution":

KEYSTROKE	DISPLAY
Conv = *(Prefs) (first press of =)*	**FRAC 0-1/16 INCH**
+ *(plus sign)*	**FRAC 0-1/32 INCH**
+	**FRAC 0-1/64 INCH**
+	**FRAC 0-1/2 INCH**
+	**FRAC 0-1/4 INCH**
+	**FRAC 0-1/8 INCH**

To Set "Area" Answer Format:

KEYSTROKE	DISPLAY
= *(second press of =)*	**AREA Std.**
+ *(plus sign)*	**AREA 0. SQ FEET**
+	**AREA 0. SQ M**

To Set "Volume" Answer Format:

KEYSTROKE	DISPLAY
= *(third press of =)*	**VOL Std.**
+ *(plus sign)*	**VOL 0. CU FEET**
+	**VOL 0. CU M**

To Increase or Decrease Tread Width from Default of 10":

KEYSTROKE	DISPLAY
= *(fourth press of =)*	**T-WD 10 INCH**
+* *(plus sign increases height by 1/4 Inch)*	**T-WD 10-1/4 INCH**
−* *(minus sign decreases height by 1/4 Inch)*	**T-WD 10 INCH**

**Keep pressing plus or minus to increase or decrease 1/4 Inch at a time.*

To Increase or Decrease Stairwell "Headroom" from Default of 6'8":

KEYSTROKE	DISPLAY
= *(fifth press of =)*	**HDRM 6 FEET 8 INCH**
+* *(plus sign increases height by 1 Inch)*	**HDRM 6 FEET 9 INCH**
−* *(minus sign decreases height by 1 Inch)*	**HDRM 6 FEET 8 INCH**

**Keep pressing plus or minus to increase or decrease an Inch at a time.*

(Cont'd)

(Cont'd)

To Increase or Decrease Floor Thickness from Default of 10":

KEYSTROKE	DISPLAY
⊖ *(sixth press of ⊖)*	**FLOR 10 INCH**
⊕* *(plus sign increases height by 1 Inch)*	**FLOR 11 INCH**
⊖* *(minus sign decreases height by 1 Inch)*	**FLOR 10 INCH**

**Keep pressing plus or minus to increase or decrease an Inch at a time.*

To Set Jack Rafter to "Descending" or "Ascending":

KEYSTROKE	DISPLAY
⊖ *(seventh press of ⊖)*	**JACK dESCEnd**
⊕ *(plus sign)*	**JACK ASCEnd**

To Set Irregular Jack Spacing to "On-Center" or "Mate":

KEYSTROKE	DISPLAY
⊖ *(eighth press of ⊖)*	**IRJK OC-OC**
⊕ *(plus sign)*	**IRJK JAC-JAC**

To Set "Exponential Mode" On or Off:

KEYSTROKE	DISPLAY
⊖ *(ninth press of ⊖)*	**EXP On**
⊕ *(plus sign)*	**EXP OFF**

To Set "Meter" Linear Decimal Format:

KEYSTROKE	DISPLAY
⊖ *(tenth press of ⊖)*	**METR 0.000 M**
⊕ *(plus sign)*	**METR FLOAt M**

To Set "Degrees" Rounding/Display:

KEYSTROKE	DISPLAY
⊖ *(eleventh press of ⊖)*	**DEG FLOAt**
⊕ *(plus sign)*	**DEG 0.00°**

(Cont'd)

(Cont'd)

To Set Mathematical Operations Method:

KEYSTROKE	DISPLAY
= *(twelfth press of =)*	**MATH OrdEr**
+ *(plus sign)*	**MATH CHAIn**

To Set Fractional Mode:

KEYSTROKE	DISPLAY
= *(thirteenth press of =)*	**FRAC Std.**
+ *(plus sign)*	**FRAC COnSt**
+ *(repeats options)*	**FRAC Std.**

Note: Press On/C at any time to exit the Preference Mode. To Reset your calculator to the default Preference Settings, turn off your calculator, hold down the multiplication × key, and turn on. "ALL rESEt" will flash for one second before clearing the display.

APPENDIX H — *CARE INSTRUCTIONS*

Please follow the guidelines listed in this section for proper care and operation of your calculator. Not following the instructions listed below may result in damage not covered by your warranty. Refer to the Repair and Return section on **page 116** for more details.

Do not expose calculator to temperatures outside the operating temperature range of 32ºF – 104ºF (0ºC – 40ºC).

Do not expose calculator to high moisture such as submersion in water, heavy rain, etc.

APPENDIX I — *ACCURACY, AUTO SHUT-OFF, BATTERIES, ERRORS*

Accuracy/Errors

Accuracy/Display Capacity — Your calculator has a twelve-digit display made up of eight digits (normal display) and four fractional digits. You may enter or calculate values up to 19,999,999.99. Each calculation is carried out internally to ten digits.

Errors — When an incorrect entry is made, or the answer is beyond the range of the calculator, it will display the word "ERROR." To clear an error condition you must hit the **On/C** button once. At this point you must determine what caused the error and re-key the problem.

Error Codes:

Display	Error Type
0-fL0	Overflow (too large to display)
EXP Error	Exponent Error
DIV Error	Divide by 0 Error
DIM Error	Dimension error
ENT Error	Entry error
TYP Error	Type error
TRIG Error	Trig. error (for example, tan of 1 foot)
None	Attempt to calculate stairs without entering rise or run

Auto-Range — If an "overflow" is created because of an input and calculation with small units that are out of the standard range of the display (e.g. 19,999,999.99), the answer will be automatically expressed in the next larger units (instead of showing "**ERROR**") — e.g., 20,000,000 mm is shown as 20,000 m. Also applies to inches, feet and yards.

Note: If Exponential Notation is activated through the Preference Setting, the value will be shown in scientific notation (e.g., 100 million mm—1.000000^{8} mm).

Auto Shut-Off

Your calculator is designed to shut itself off after about 8-12 Minutes of non-use.

Battery(ies)

- Two LR44 batteries.

Replacing the Battery(ies)

Should your calculator display become very dim or erratic, replace the battery(ies).

Note: Please use caution when disposing of your old battery, as it contains hazardous chemicals.

Replacement batteries are available at most discount or electronics stores. You may also call Calculated Industries at 1-775-885-4975.

Battery Replacement Instructions

To replace the batteries, slide open the battery door (at top backside of unit) and replace with new batteries. Make sure the batteries are facing positive side up.

Reset Key

If your calculator should ever "lock up," press Reset — a small hole located to the left of the **Off** key — to perform a total reset.

WARRANTY, REPAIR AND RETURN INFORMATION

Return Guidelines

1. Please read the ***Warranty*** in this User's Guide to determine if your Sheet Metal/HVAC Pro Calc calculator remains under warranty ***before*** calling or returning any device for evaluation or repairs.
2. If your calculator won't turn on, try pressing the **Reset** button first. If it still won't turn on, check the batteries as outlined in the User's Guide.
3. **If there is a black spot on the LCD screen, THIS IS NOT A WARRANTY DEFECT. The unit can be repaired. Call for a repair quote before returning your unit.**
4. If you need more assistance, please contact the dealer through which you initially purchased the product.

WARRANTY

Warranty Repair Service – U.S.A.

Calculated Industries ("CI") warrants this product against defects in materials and workmanship for a period of one (1) year from the date of original consumer purchase in the U.S. If a defect exists during the warranty period, CI at its option will either repair (using new or remanufactured parts) or replace (with a new or remanufactured calculator) the product at no charge.

THE WARRANTY WILL NOT APPLY TO THE PRODUCT IF IT HAS BEEN DAMAGED BY MISUSE, ALTERATION, ACCIDENT, IMPROPER HANDLING OR OPERATION, OR IF UNAUTHORIZED REPAIRS ARE ATTEMPTED OR MADE. SOME EXAMPLES OF DAMAGES NOT COVERED BY WARRANTY INCLUDE, BUT ARE NOT LIMITED TO, BATTERY LEAKAGE, BENDING, OR VISIBLE CRACKING OF THE LCD, WHICH ARE PRESUMED TO BE DAMAGES RESULTING FROM MISUSE OR ABUSE.

To obtain warranty service in the U.S., please contact the dealer through which you initially purchased the product.

A repaired or replacement product assumes the remaining warranty of the original product or 90 days, whichever is longer.

Non-Warranty Repair Service – USA

Non-warranty repair covers service beyond the warranty period or service requested due to damage resulting from misuse or abuse.

Contact Calculated Industries at 1-775-885-4900, to obtain current product repair information and charges. Repairs are guaranteed for 90 days.

Repair Service – Outside the USA

To obtain warranty or non-warranty repair service for goods purchased outside the U.S., contact the dealer through which you initially purchased the product. If you cannot reasonably have the product repaired in your area, you may contact CI to obtain current product repair information and charges, including freight and duties.

Disclaimer

CI MAKES NO WARRANTY OR REPRESENTATION, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT'S QUALITY, PERFORMANCE, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. AS A RESULT, THIS PRODUCT, INCLUDING BUT NOT LIMITED TO, KEYSTROKE PROCEDURES, MATHEMATICAL ACCURACY AND PREPROGRAMMED MATERIAL, IS SOLD "AS IS," AND YOU THE PURCHASER ASSUME THE ENTIRE RISK AS TO ITS QUALITY AND PERFORMANCE.

IN NO EVENT WILL CI BE LIABLE FOR DIRECT, INDIRECT, SPECIAL,

INCIDENTAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT IN THE PRODUCT OR ITS DOCUMENTATION.

The warranty, disclaimer, and remedies set forth above are exclusive and replace all others, oral or written, expressed or implied. No CI dealer, agent, or employee is authorized to make any modification, extension, or addition to this warranty.

Some states do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific rights, and you may also have other rights, which vary from state to state.

FCC Class B

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC rules.

Legal Notes

Looking For New Ideas

Calculated Industries, a leading manufacturer of special-function calculators and digital measuring instruments, is always looking for new product ideas in these areas.

If you have an idea, or a suggestion for improving this product or User's Guide, please submit your comments online at: www.calculated.com under "Contact Us," "Product Idea." Thank you.

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