Principles of Square Roots Lesson Plan

Concept/principle to be demonstrated:

This lesson will demonstrate how to layout and use a calculator to determine right triangles (Pythagorean Theorem). The right triangle is used extensively for layout in construction. The simplest way to lay out a 90° angle is to use the 3-4-5 method. Understanding is demonstrated by applying the formula ($a^2 + b^2 = c^2$) to solve additional construction related problems using a calculator.

Lesson objectives/Evidence of Learning:

- Explains the meaning of the square root of a number
- Uses physical, symbolic and technological models to explore conjectures
- Uses basic 2-D figures such as circles or polygons to represent objects essential to a situation
- Calculates the area and perimeter of right triangles
- Uses the Pythagorean Theorem in 2-D and 3-D situations when appropriate to compute unknown distances

Objectives for Part I of Lesson:

Given paper, pencil, and ruler, students will layout triangles on 11” x 17” paper. All measurements shall be accurate to within 1/16.”

Objectives for Part II of Lesson:

- Comprehends concept of Pythagorean Theorem
- Knows meaning of terms and symbols
- Applies formula to solve variety of construction problems
- Understands uses calculator to compute accurately

How this math connects to construction jobs:

The Pythagorean Theorem is used extensively by carpenters in construction. This lesson will help students comprehend how right triangles are used to align everything from conduits to walls.

- **Electricians** use right triangle to make off-sets when bending conduit.
- **Carpenters** apply the Pythagorean Theorem to check the diagonal of a foundation or framed wall to determine if it is square.
- **The right triangle** is the key to making stair stringers and roof rafters.
- **Plumbers** have fittings that allow them to make perfect 90° angles.
- **Surveyors** use sophisticated instruments to square property corners.

Teacher used training aids:

- 6," 8" and 10" plywood or card stock squares marked with 2" grids
- Additional 8" square cut into 4 pieces
- 16' tape
- Framing square with rafter table (optional)
- 12' rope loop with knots every foot (optional)

Materials needed per student:

- 11" x 17" paper
- 12" ruler
- Pencil
- Calculator with √ key & memory +/- functions
- ***Principles of Square Roots Worksheets***
- ***Principles of Square Roots Applied to Right Triangles*** handout
- ***Right Triangles Wordsearch***

Terms:

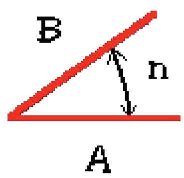
- **Altitude (rise):** The perpendicular distance from the vertex to the base.
- **Angle:** The union of two rays with a common endpoint, called the vertex.
- **Base (run):** The bottom of a plane figure or three-dimensional figure.
- **Diagonal:** The line segment connecting two nonadjacent vertices in a polygon.
- **Hypotenuse:** The side opposite the right angle in a right triangle.
- **Right angle:** An angle whose measure is 90 degrees.
- **Square root (√):** The square root of x is the number that, when multiplied by itself, gives the number, x.

Lesson Introduction:

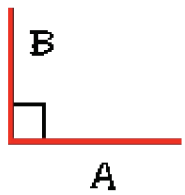
In building layout and floor framing, buildings are checked for square. The 3-4-5 method is commonly used. This is a very old method developed by the Greeks. It's called the Pythagorean Theorem. Here's the deal: there was this Greek guy named Pythagoras, who lived over 2,000 years ago during the sixth century B.C. Pythagoras spent a lot of time thinking about math, astronomy, and music. One idea he came up with was a mathematical equation that's used all the time in architecture, construction, and measurement. What is important is how to use the theory to layout right triangles. I'll use this rope to demonstrate. Today, you will work in your teams to layout triangles on paper. Then use calculators to solve construction related problems.

Lesson Components:

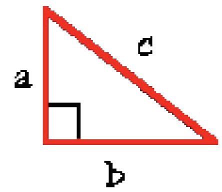
1. Draw on white board and explain:



angle,



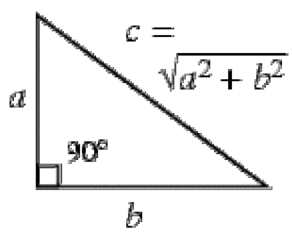
90° angle and



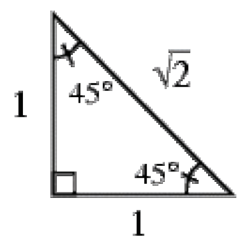
right triangle

2. Right triangles are special:

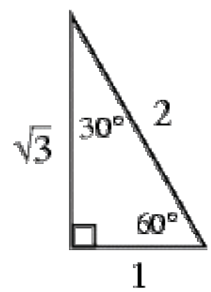
    a. Used extensively in construction.
    b. 45°-45°-90° and 30°-60°-90° have unique qualities.



general right triangle



isosceles right triangle



30–60–90° triangle

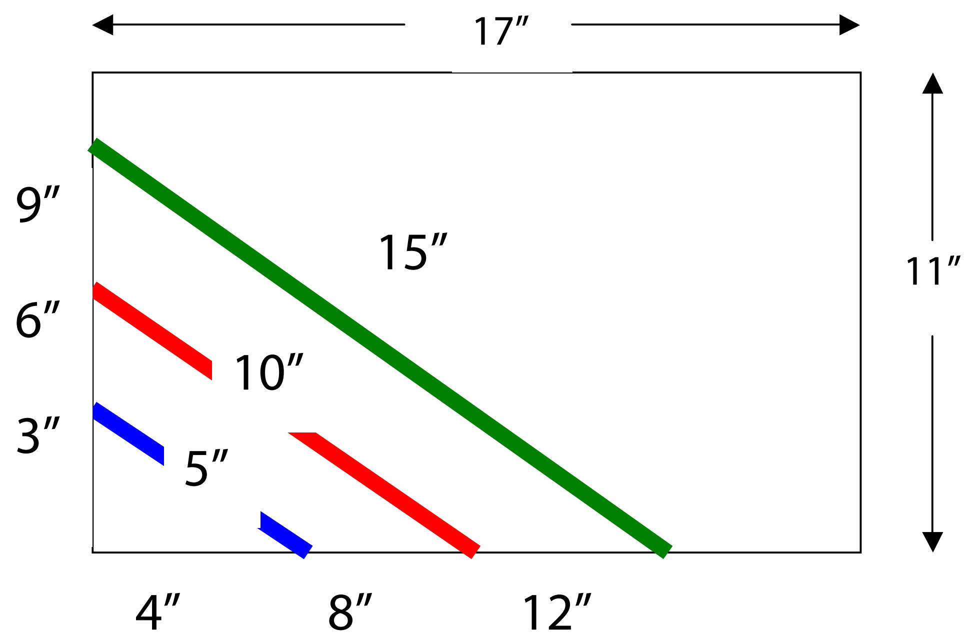
3. Construction terms and uses:

    a. Base is run. Used in roofs and stairs
    b. Altitude is rise. Also used in roofs and stairs.
    c. Electricians and plumbers also use right triangle. Off-set is another term.
    d. Hypotenuse is diagonal when squaring rectangles; used in framing& forms

4. **Demonstration** for 3-4-5

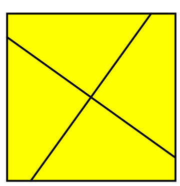
    a. Measure the up 3” on end of paper & mark.
    b. Measure allow long edge 4” & mark
    c. Draw a line from mark to mark.
    d. Measure the length of the line (5”).
    e. Note: this can be done on a white board using a 16” tape. Measurements become 3’, 4’ and 5.’ Layout is done by swinging an arch to establish pts.

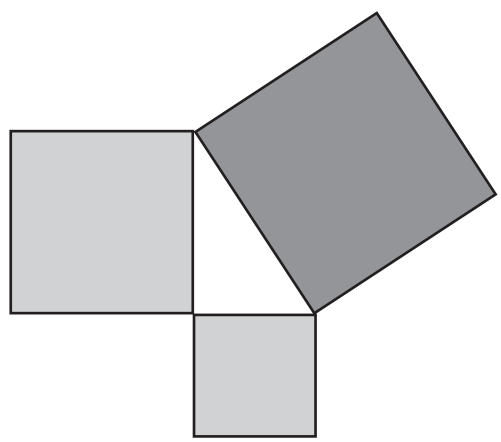
5. Students practice layout and measure 90° triangles.



6. Why does this work? Show cutouts. Also demonstrate how the cut 4^2 pieces fit around 3^2 to form 5^2.

   Cuts of spare 4” square





7. Hand out calculators and ***Principles of Square Roots Worksheets.***

   a. Explain keys (memory +/-, √ etc)
   b. Practice drill with calculators

8. Review $a^2 + b^2 = c^2$ on board

   a. Insert 3-4-5
   b. Have students practice keys

9. Explain relationship of formula substitute 3-4-5

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

10. Solve problems using √ key

    a. Work in teams
    b. Encourage correct responses

11. Explain construction uses for right triangle:

    a. Wall braces, stair stringers, roof rafters, floors, and foundations.
    b. Open responses to excavation questions.
    c. Assist student teams solve wall brace questions

Review:

1. What are some of the ways right triangle is used in construction?
2. Explain 3-4-5. What does c^2 equal? Who can explain "Square root"?
3. The framing square has a table printed (all runs are 12"). Show table.
4. What is the hypotenuse of a triangle with a 12" run and 5" rise? (use calculator)
5. Questions?

Additional resources: ***Right Triangles Wordsearch***

Name ________________________________

Principles of Square Roots Worksheets

Apply the principles of square root to carpentry by solving the following problems (round answers to two decimal places):

Problem #1 (key strokes: enter number followed by the √ key)

a. $\sqrt{81}$ __________________

b. $\sqrt{100}$ __________________

c. $\sqrt{169}$ __________________

d. $\sqrt{892}$ __________________

e. $\sqrt{1235}$ __________________

f. $\sqrt{1692}$ __________________

Problem #2

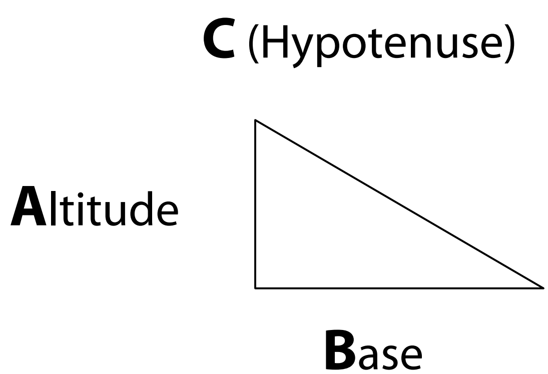
Using the following formulas, solve for the missing dimension:
(key strokes: number, x^2 key, plus key, number, x^2 key, equals, √ key)

$\mathbf{C = \sqrt{A^2 + B^2}}$ $\mathbf{B = \sqrt{C^2 - A^2}}$ $\mathbf{A = \sqrt{C^2 - B^2}}$

a. Find C if A = 9" and B = 10" __________

b. Find B if C = 7" and A = 5" __________

c. Find A if C = 27" and B = 13" __________

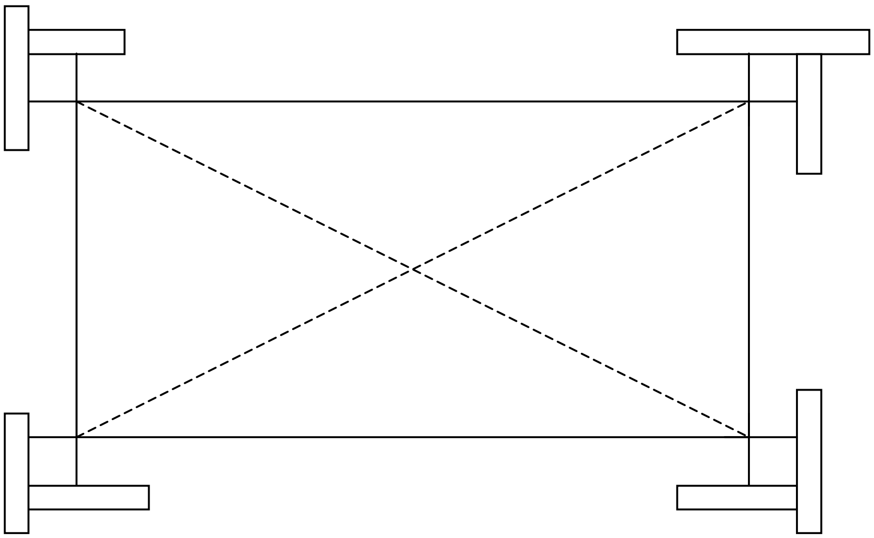


Problem #3

In the illustration below the rectangle represents the lines of excavation for the foundation of a house.

a. If the house is 45’-0” long and 27’-0” wide, what is the length of the diagonals? ____________

b. What is the diagonal in feet and inches to the nearest 1/16? ______________________



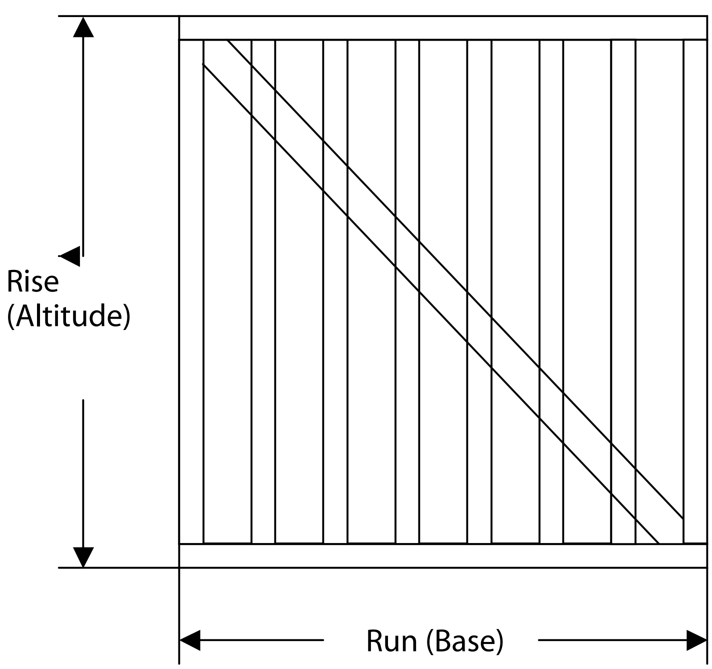
Problem #4

Use the illustration of the wall brace and find the length of the brace (diagonal) for each of the following problems:

a. Wall height is 6’-0” and the run is 9’-0”_____________________

b. Wall height is 18’-0” and the run is 26’-0”___________________

c. Wall height is 3’-6” and the run is 6’-6”_____________________



Principles of Square Roots Worksheets

Apply the principles of square root to carpentry by solving the following problems (round answers to two decimal places):

Problem #1 (key strokes: enter number followed by the √ key)

a. $\sqrt{81}$ **9**

b. $\sqrt{100}$ **10**

c. $\sqrt{169}$ **13**

d. $\sqrt{892}$ **29.87**

e. $\sqrt{1235}$ **35.14**

f. $\sqrt{1692}$ **41.13**

Problem #2

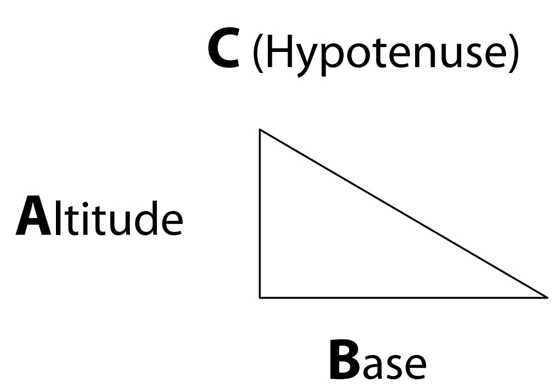
Using the following formulas, solve for the missing dimension:
(key strokes: number, x^2 key, plus key, number, x^2 key, equals, √ key)

$C = \sqrt{A^2 + B^2}$ $B = \sqrt{C^2 - A^2}$ $A = \sqrt{C^2 - B^2}$

a. Find C if A = 9" and B = 10" **13.45"**

b. Find B if C = 7" and A = 5" **8.60"**

c. Find A if C = 27" and B = 13" **29.97"**



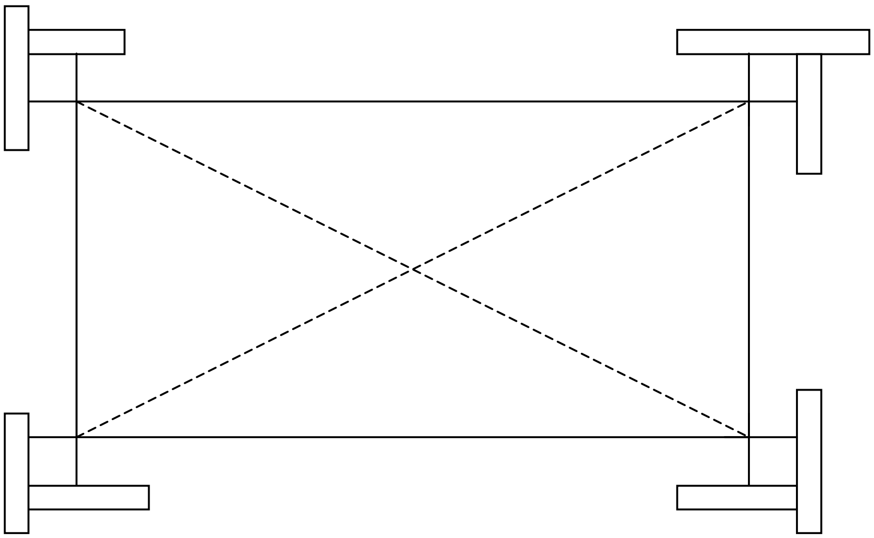
Problem #3

KEY

In the illustration below the rectangle represents the lines of excavation for the foundation of a house.

a. If the house is 45'-0" long and 27'-0" wide, what is the length of the diagonals? **52.48'**

b. What is the diagonal in feet and inches to the nearest 1/16? **52'-5.75"**



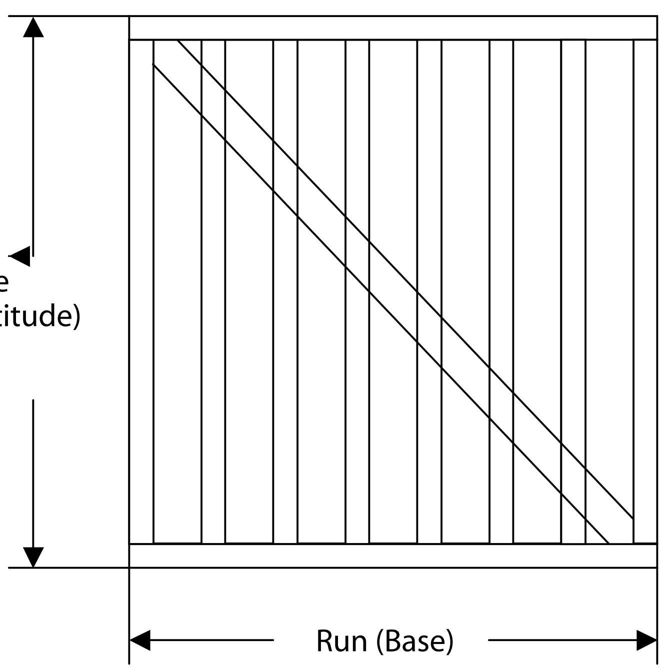
Problem #4

Use the illustration of the wall brace and find the length of the brace (diagonal) for each of the following problems:

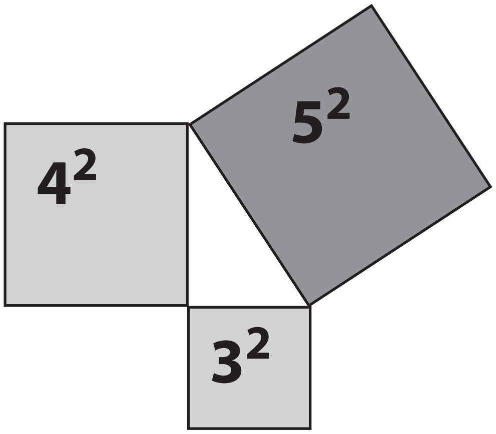
a. Wall height is 6'-0" and the run is 9'-0" **10.82'**

b. Wall height is 18'-0" and the run is 26'-0" **31.62'**

c. Wall height is 3'-6" and the run is 6'-6" **7.47' or 88-9/16"**



Principles of Square Root
Applied to Right Triangles



The right triangle shown here illustrates an important application of a formula which is used to find the length of a third side of a triangle if two sides are known. The square of the hypotenuse of a right triangle is square to the sum of the squares of the two sides.

Pythagorean Theorem

$$(\text{hypotenuse})^2 = A^2 + B^2$$
$$25 = 16 + 9$$

It can also be seen that:

$A^2 = C^2 - B^2$
$16 = 25 – 9$
$B^2 = C^2 - A^2$
$9 = 25 – 16$

Right Triangles Wordsearch

M	T	A	P	Y	T	H	A	G	O	R	A	S	L	B
T	N	H	I	S	F	U	N	A	N	D	E	E	A	A
S	E	Y	C	F	K	A	J	W	L	P	G	S	Y	A
E	M	N	U	R	Q	H	E	C	A	C	E	M	O	F
J	E	L	L	R	N	R	T	H	X	L	C	B	U	L
T	R	L	R	D	F	S	S	J	L	C	F	H	T	F
S	U	I	G	M	L	Y	Z	F	U	R	Q	V	A	K
Z	S	U	G	N	U	U	B	R	X	A	J	K	O	D
Z	A	V	Z	H	A	T	O	I	X	S	G	L	E	A
K	E	Y	Q	K	T	I	J	S	S	N	D	R	A	E
J	M	W	L	H	G	A	R	E	K	S	A	J	V	R
K	O	P	D	T	W	R	N	T	E	U	G	Y	Z	A
C	I	R	T	E	M	O	E	G	Q	V	Z	A	F	X
A	L	T	I	T	U	D	E	S	L	F	V	L	Q	K
S	Y	Y	I	S	S	Q	U	A	R	E	R	O	O	T

ALTITUDE
ARC
AREA
BASE
GEOMETRIC
LAYOUT
MEASUREMENT
PYTHAGORAS
RIGHTANGLE
RISE
RUN
SHAPES
SQUARED
SQUAREROOT
TRIANGLE