



<b>Author(s):</b> Michael Lucky Voiselle			<b>Lesson Title:</b> HOW TALL IS THAT BUILDING?			
<b>Grade Span</b>			<b>ICLE Application Model</b>			
K-4	5-8	9-12 X	A	B	C	D X

**Instructional Focus:**

**Writing**

Students write for a variety of purposes and audiences with sophistication and complexity appropriate to the grade level.

**Algebraic Concepts and Relationships**

Students use algebraic methods to investigate, model, and interpret patterns and functions involving numbers, shapes, data, and graphs in a problem-solving situation. Students evaluate and communicate the reasoning used in solving these problems.

**Science as Inquiry**

Students demonstrate knowledge and skills necessary to perform scientific inquiry.

**Communication**

Students communicate and apply scientific concepts.

**Performance Task**

You are to determine the height of your school gym, or a flagpole, or a nearby telephone pole. Divide into groups of two or three students and analyze the diagram that accompanies this experiment.

You will need a metric tape measure, a stick or a rod of known height (a meter stick will do), and a protractor to measure the proper angle if needed. Remember that right triangles are similar; meaning each has a right angle, 90 degrees, in common. If the triangles share another angle in common, then some proportions can be made. Therefore, you should be able to accurately predict the dimension of an unknown side using trigonometry or algebraic proportions developed by the ancient Greeks 2500 years ago.

The hypotenuse, the longest side of your right triangle, will be a shadow line from the top of the unknown height to where the shadow hits the ground. After your group has analyzed the diagrams, you are to record your measured data in a neatly organized chart. Duplicate the diagram and record the data on the diagram also. All calculations including the numerical values and units must be clearly shown below your diagram. Keep in mind you must communicate with your group members. Each member must write a conclusion paper that is neatly organized and free from spelling and grammatical errors.

You need to research and include in your paper the thoughts of Thales, an interesting Greek thinker studying in Europe at the time. His life was on the line when he used his ideas on proportions to determine the height of the Great Pyramid upon the request of the Pharaoh at the spur of the moment. Here you need to include information on the Egyptian magic shadow-stick, the Egyptian rope-stretchers, and the Egyptian land-measurers.

Your write-up needs to address the following questions. Why is a 3x4x5 right triangle considered a perfect triangle? You will need to research the life of Pythagoras, a Phoenician mathematician, who developed the Pythagorean Theorem and built upon Thales' works to solidify the Law of Proportions.

You are to construct a right triangle measuring 3cm x 4cm x5cm somewhere in your write-up. Extend each side of the triangle into a square. For instance, use the 3cm side of the triangle to draw a 3cm square budding off the triangle. Repeat this procedure using the 4cm and 5cm lines to have a 4cm and a 5cm square budding off the other two sides of the triangle. Consult the accompanying diagram. What you have is a triangle in the middle of the 3 squares. Compare the

areas of the two smaller squares by adding the 3cm and the 4cm squares together to the area of the larger 5cm square. To aid you in this task, mark off the squares into smaller 1cm squares. Then count the number of 1cm boxes in the two smaller squares added together. Compare to the count of the 1cm squares in the larger 5cm square. What can you deduce from that? How does this compare to the Pythagorean Theorem? Include a discussion of this in your write-up.

How can a carpenter use this 3x4x5 triangle to square off the foundation of a newly constructed building? Keep in mind the carpenter needs to have a right angle in all four corners of the building.

Your write-up must include any problems you encountered and how you and your group solved them. You may use any resources available including fellow students, teachers, textbooks, and the internet.

### ICLE Essential Skills

Apply in writing the rules and conventions of grammar, usage, punctuation, paragraphing and spelling. (ela1)

Gather information from a variety of sources, including electronic sources, and summarize, analyze, and evaluate its use for a report. (ela3)

Use expository writing skills in subjects other than English language arts. (ela58)

Understand **basic algebraic properties** (i.e., commutative:  $ab = ba$ ; associative:  $ab(c) = a(bc)$ ; and distributive:  $a(b+c) = (ab)+(ac)$ ). (m3)

Understand the **angle relationships in triangles** (i.e., acute, obtuse, right, interior, and exterior). (m14)

Understand the concepts of **right triangle trigonometry** and solve right triangles using basic trigonometric ratios (sine, cosine, tangent). (m57)

Make observations using senses and instruments. Inferences and interpretations are arrived at based on observations. Classify observable properties and organize observations in a meaningful and logical way. (s5)

Exhibit good data management skills by collecting, organizing, and graphing data. (s19)

### Scoring Guide:

RATE THE CRITERIA: 3=Excellent, 2=satisfactory, 1=unsatisfactory, 0=does not attempt or work is not acceptable

CRITERIA	SCORE
Experimental procedure and group cooperation	_____
Neatly organized data table and diagrams	_____
Accuracy of results and proper algebraic manipulation	_____
Thales and his life in Egypt is addressed	_____
Pythagoras and the Pythagorean Theorem addressed	_____
Shows understanding of 3x4x5 right triangle with a neat diagram	_____
Answers questions in a clear concise manner	_____
Conclusion write-up is neatly organized and free from spelling and grammatical errors 2errors=3, 5errors=2, 8errors=1, 0=>8errors	_____

**Keywords**

English Language Arts	Mathematics	Science
Reading independent reading research	Algebra algebraic operations equations measurement problem solving	Earth Science
Writing grammar spelling expository	Geometry	Life Science
Communications	Statistics	Chemistry
Literature	Calculus	Physics scientific process
Other	Trigonometry functions	Other history of science
	Other history of mathematics	

If you have a Picture, Chart, or Graph that has special formatting, please identify the name of the file(s) in box below. Also attach a copy of the file(s) with this disk.

Picture, Chart, or Graph file name(s):

Long side is the shadow cast by the height being measured

Unknown Height (Flagpole)  $h_2$

Meter stick value Measurable  $h_1$

Common angle (measurable)  $\theta$

Measurable  $l_2$

Measurable  $l_1$

Use this concept to aid in the construction of a 3 x 4 x 5 right triangle.

From trigonometry we know:

$$\tan \theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{h_2}{l_2}$$

If you know how to use the trig function on a calculator, you can determine the height from this formula.

Also from trigonometry we know:

$$\tan \theta = \frac{h_1}{l_1} \text{ therefore: } \frac{h_2}{l_2} = \frac{h_1}{l_1}$$

These two ratios are equal because they are equal to the same  $\tan \theta$ . Solve for  $h_2$  (the unknown) because the other three variables are measurable.

