

Math-in-CTE Lesson Plan Template

Lesson Title: Scaffold/Ladder-Similar Triangles		Lesson #4
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Occupational Area: Building Construction		
CTE Concept(s): Ladder Safety		
Math Concepts: Similar Triangles		
Lesson Objective:	Proper set-up of a straight or extension ladder	
Supplies Needed:	NCCER Core Curriculum-Basic Safety or applicable text, Ladders, Tape measure, Mirror (6"X3" or larger)	

THE "7 ELEMENTS"	TEACHER NOTES (and answer key)
<p>1. Introduce the CTE lesson.</p> <p>Today we are going to talk about and set up various types of ladders used in the construction industry.</p> <p>Lets go over ladder safety Do's and Don'ts from your text.</p> <p>In order for a straight or extension ladder to be safe and stable there is a distance away from the base of the wall in relation to the height that the bottom of the ladder should be placed.</p>	<p>Ask students what types of ladders they have used.</p> <p>Show different types of ladders</p> <p>Describe the proper positioning of a straight of extension ladder (the base is set out $\frac{1}{4}$ of the height)</p> <p>Talk about the three point contact rule of climbing a ladder</p>

<p>2. Assess students' math awareness as it relates to the CTE lesson.</p> <p>As we go through this lesson I am going to use some terms like RATIO, AND SIMILAR TRIANGLES. Who would like to take a shot at defining these?</p> <p>We are now going to stand a ladder against the classroom wall. Lets go over the procedure.</p>	<p>RATIO=The comparison of two numbers by division (see work sheet#2)</p> <p>SIMILAR TRIANGLES=Two triangles whose corresponding angles are congruent and whose corresponding sides are proportional.</p> <p>Demonstrate: Determining the base location of the ladder</p> <p>Proper raising of a ladder with and without help</p> <p>Extending the ladder above the platform 3'</p> <p>Tying off the ladder</p>
<p>3. Work through the math example <i>embedded</i> in the CTE lesson.</p> <p>Lets try a couple of examples where you find the distance your ladder should be away from a wall when you know the height of the wall and you know your ladder is tall enough.</p>	<p>Work sheet #1 Ladder safety problems</p> <p>See work sheets below</p> <p>1.ans.D 2.ans D 3.ans D 4.ans 4.25'</p>
<p>4. Work through <i>related, contextual</i> math-in-CTE examples.</p> <p>Sometimes you may not be able to easily measure the height of a wall and, for ease of installation, you would like to know where to put the base of the ladder. Here are a few techniques. If the wall is divided into some type of "unit" such as bricks, blocks, clapboards etc., measure the size of one unit and multiply by the number of units.</p>	<p>Have the students estimate the height of a wall that is made from some type of measureable unit</p> <p>(Size of unit) (Number of units)= wall height</p>

<p>If the wall is smooth, you might try a method using “similar triangles”.</p> <p>Here is a sheet that explains the process</p>	<p>Worksheet 2 & 2a</p> <p>Discuss the “mirror” technique to determine the height of the shop wall</p> <div data-bbox="1102 386 1213 462" data-label="Image"> </div> <p>h1= wall height</p> <p>d1= distance from wall to mirror</p> <p>h2= height to your eye</p> <p>d2= distance from you to mirror</p>
<p>5. Work through <i>traditional math</i> examples</p> <p>At this time please complete the work sheet I just gave you.</p>	<p>Worksheet #3 Mirror Method</p> <p>1. Height=(5)(20)/5=20 feet</p> <p>2. Height=(5)(30)/3=50 feet The ladder is too short.</p>
<p>6. Students demonstrate their understanding.</p> <p>Now I would like you to break up into three groups, take a ladder outside to the marked off area and using two of the methods we have covered, determine the height of the wall and erect a ladder using the procedures we discussed earlier.</p>	<p>Be sure to secure an area for practice</p> <p>Pre measure the height of the wall</p> <p>Provide ladders long enough to extend at least 3’ beyond the step off point</p>
<p>7. Formal assessment.</p> <p>Through out the year we (you and I) will use the LADDER AND SCAFFOLD rubric to evaluate your ability.</p>	<p>LADDER AND SCAFFOLD RUBRIC – to be developed by instructor</p> <p>NCCER test and evaluation</p>

Worksheet #1 Ladder Safety Problems

1. You have a wall that is 20 feet high, your ladder is 32 feet, following the safety rules discussed today how far from the wall should the ladder be placed?
 - a. 2 feet
 - b. 3 feet
 - c. 4 feet
 - d. 5 feet

2. If your wall is 28 feet and your ladder is 40 feet long, how far from the base will you place the ladder?
 - a. 5 feet
 - b. 5.5 feet
 - c. 6 feet
 - d. 7.5 feet

3. Our wall is 23 feet and our ladder is 36 feet, how far from the base should we place our ladder?
 - a. 4.7 feet
 - b. 4.9 feet
 - c. 5.4 feet
 - d. 5.8 feet

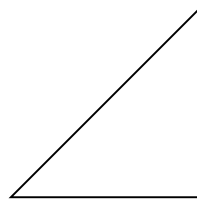
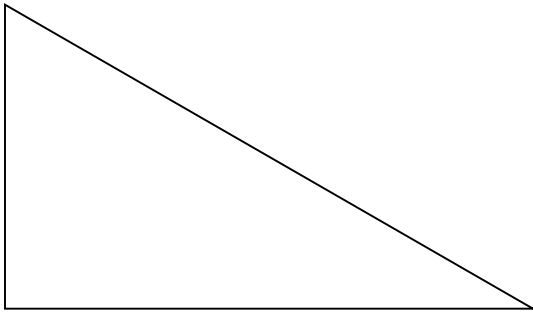
4. If the eave height is 17 feet, how far from the base of the wall should we place the feet of the ladder?

Worksheet #2 Mirror method using Similar Triangles

In geometry when we have two similar triangles we can find the leg height of one of the triangles when the base length is known of both triangles and we know the height of one of the triangles.

Definition of Similar Triangles: Two triangles that have the same angle measures but have different side lengths.

Example #1 We have two similar triangles.



The larger triangle has a base length of d_1

The smaller d_2

The larger triangle has a height of h_1

The smaller h_2

The ratio of height to base of similar triangles are equal therefore:

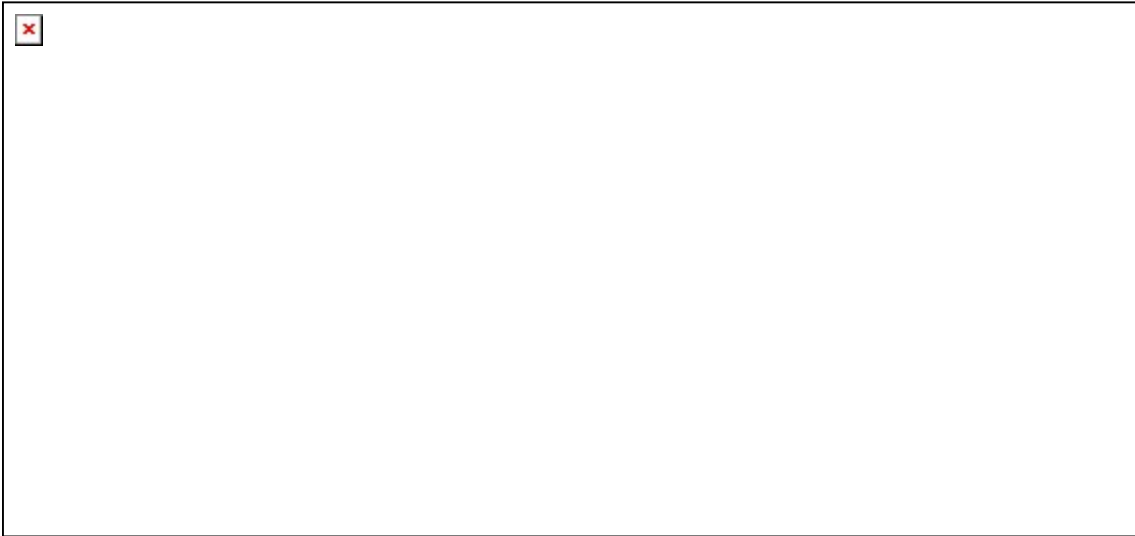
$$h_1/d_1 = h_2/d_2$$


If the base of the small triangle $d_2 = 4'$ and its height $h_2 = 6'$ and

If the base of the larger triangle $d_1 = 20'$ we can calculate the height h_1 of the larger triangle using the above ratio formula.

So $h_1/20 = 6/4$ which gives us $h_1 = (6)(20)/(4) = 30'$

Mirror Method #2a



1. View object in mirror where ladder will rest (Be sure the mirror is level).
2. Measure center of mirror to base of wall. (d1)
3. Measure center of mirror to person doing the observation (d2)
4. Measure eyeball height of person. (h2)
5. Solve 



20 feet

The accuracy of the measurements is critical.

1. You are at the job site and must determine the height of the roof edge to use the appropriate ladder. You decide to use the mirror method to accomplish this.
You place the mirror 20 feet from the building and step back till you see the roof edge in the mirror. Your distance from the mirror at that point is 5 feet. You know your eye height above ground level is 5 feet. What is the roof edge height?

2. You have a 40 foot ladder on your truck and you would prefer not to carry it to the building since you are not sure if it is long enough to reach the eaves of the building you are working on. Again using your tape and mirror, you find that with the mirror 30 feet from the base of the building and you are 3 feet from the mirror, with your same eye height of 5 feet. Will your 40 foot ladder be long enough to do the job or will you need to use scaffolding? (Show your computations)

1. $20 \div 4 = 5$ ans. D
2. $28 \div 4 = 7$ ans. D
3. $23 \div 4 = 5.75$ ans. D (rounding)
4. $17 \div 4 = 4.25$ feet

Worksheet #3 solutions

1. height = $(5)(20)/5 = 20$ feet
2. height = $(5)(30)/3 = 50$ feet, ladder too short.