BUILDING INDUSTRY TECHNOLOGY ACADEMY

A program promoted by the California Homebuilding Foundation

PROJECT #3:

BUILDING A RAMP

California Homebuilding Foundation®
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YEAR TWO
PROJECT #3 BUILDING A RAMP

Table of Contents

Lesson #1: The Pythagorean Theorem (2 days)

Objectives

Students will be able to...

- Determine the distance between two points on a coordinate plane using the Pythagorean theorem.

Common Core Standards

LS 11-12.6
RSIT 11-12.2
RLST 11-12.2
Writing 9-10.5
Problem Solving/Critical Thinking 5.4
Health and Safety 6.2, 6.3, 6.6, 6.12
Responsibility and Leadership 7.4, 9.3
CCSS.MATH.PRACTICE.MP6
CCSS.MATH.PRACTICE.MP2
CCSS.MATH.PRACTICE.MP1
Residential and Commercial Construction Pathway D2.1, D2.2, D3.1, D3.7

Materials

Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet
Pythagorean Theorem in Real Life Worksheet
Pythagorean Theorem Ramp Project Practice
The Pythagorean Theorem-Rubric for Ramps

Lesson Sequence

- Pass out ***Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet*** and review with the class. Answer any questions as needed (30 minutes).
- Pass out ***Pythagorean Theorem in Real Life Worksheet*** and have students work on this independently (20 minutes). Answer any questions as needed.
- Review the ***Pythagorean Theorem in Real Life Worksheet*** as a class (10-15 minutes).
- Pass out the ***Pythagorean Theorem Ramp Project Practice*** and have students practice creating a ramp (35-40 minutes).

Assessment

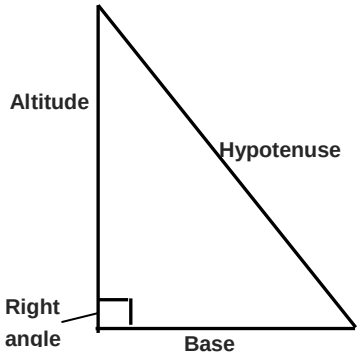
Check for understanding through questioning and calling on random students.

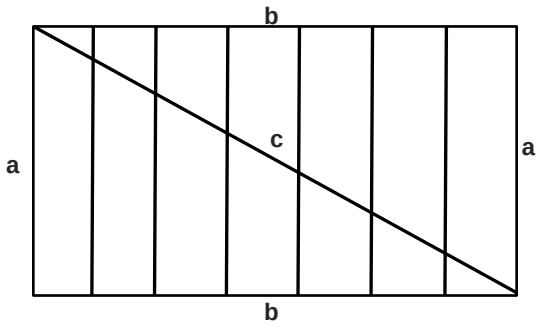
Collect worksheets and grade worksheets to check for understanding of concept. Provide additional assistance to students who may need it.

Accommodations/Modifications

Check for Understanding
One on One Support
Calculators
Scaffolded Instructions as Needed
Peer Support As Needed

Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet





Woodworkers must make sure that the sides, tops, and bottoms of casework are square to each other during assembly. In this sense, square means that the parts are at right angles to each other.

As shown in the figure, a diagonal line drawn on a rectangular surface divides the surface into two triangles. If the sides of the rectangle are truly at right angles to each other, then both triangles will be right triangles. The Pythagorean theorem can be used to determine whether the triangles are right triangles.

The Pythagorean theorem states that in a right triangle, the hypotenuse squared equals the sum of the squares of the two remaining sides. The hypotenuse is the side opposite the right angle. The formula is $a^2 + b^2 = c^2$, where 'a' is the altitude, 'b' is the base, and 'c' is the hypotenuse.

A simplified equation is c = $\sqrt{a^2 + b^2}$

e.g. a triangle with sides 5, 12, 13

$5^2+12^2 = 13^2$

25+ 44 = 169

5, 12 13 is a perfect combination and the triangle is a right-angled triangle

e.g. a triangle with sides 7,7,10

$7^2 + 7^2 = 10^2$

49 + 49 = 98

7, 7, 10 is not a perfect combination and the triangle is not a right-angled triangle because $10^2 = 100$.

Terms

Right Triangle - a triangle with one right (90-degree) angle

Pythagorean Theorem - in a right triangle, the hypotenuse squared = sum of squares of other sides

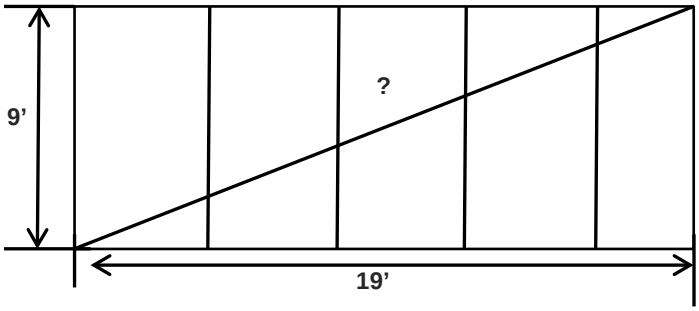
Hypotenuse - the side of a right triangle that is opposite the right angle

Altitude or Leg - the vertical side of a triangle

Base or Leg - the bottom of a triangle

Find the diagonal of a wall that is 9' high and 19' long.

Step 1	The formula is $c = \sqrt{a^2 + b^2}$
Step 2	Insert he known values. $c = \sqrt{9^2 + 19^2}$
Step 3	$c = \sqrt{81 + 361}$
Step 4	$c = \sqrt{442}$
Step 5	c = 21.0238'



Use a calculator to complete the following problems.

1. Find the diagonal of a floor that is 12' long and 14' wide.

   A) 9.2195'

   B) 18.4391'

   C) 27.6586'

   D) 36.8781'

2. Find the diagonal of a wall that is 8' high and 11' long.

   A) 13.6015'

   B) 27.2029''

   C) 40.8044'

   D) 54.4058'

3. If a floor is 15' × 22', then the diagonal is

   A) 13.3135'.

   B) 19.9703'.

   C) 26.6271'.

   D) 53.2540'.

You can use the same formula to find the length of a right triangle's leg if you are given measurements for the lengths of the hypotenuse and the other leg. Consider the example below.

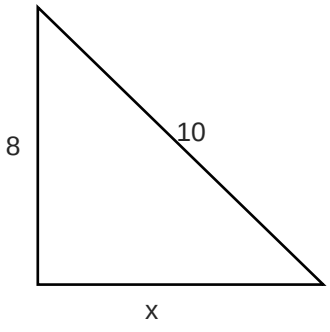
a =? b = 6 c = 7	In this right triangle, you are given the measurements for the hypotenuse, *c*, and one leg, *b*. The hypotenuse is always opposite the right angle and it is always the longest side of the triangle.
$a^2 + b^2 = c^2$ $a^2 + 6^2 = 7^2$	To find the length of leg *a*, substitute the known values into the Pythagorean Theorem.
$a^2 + 36 = 49$ $49 – 36 = 13$ $a^2 = 13$ $a \approx 3.6$	Solve for a^2. Think: what number, when added to 36, gives you 49? Use a calculator to find the square root of 13. The calculator gives an answer of 3.6055, which you can round to 3.6. (Since you are approximating, you use the symbol ≅ .)

Which of the following correctly uses the Pythagorean Theorem to find the missing side, *x?*

A. $8^2 + 10^2 = x^2$

B. $x + 8 = 10$

C. $x^2 = 8^2 = 10^2$



Pythagorean Theorem in Real Life Worksheet

Uses of Pythagoras' Theorem

You may have heard about Pythagoras's theorem (or the Pythagorean Theorem) in your math class, but what you may fail to realize is that Pythagoras's theorem is used often in real life situations. According to Pythagoras's theorem the sum of the squares of two sides of a right triangle is equal to the square of the hypotenuse. Let one side of the right triangle be a, the other side be b and hypotenuse are given by c. According to Pythagoras's theorem $a^2 + b^2 = c^2$. This is taught in every classroom throughout the world, but what isn't taught is how it can be applied outside of the classroom.

Real Life Applications

1) **Road Trip:** Let's say two friends are meeting at a playground. Mary is already at the park, but her friend Bob needs to get there taking the shortest path possible. Bob has two way he can go - he can follow the roads getting to the park - first heading south 3 miles, then heading west four miles. The total distance covered following the roads will be 7 miles. The other way he can get there is by cutting through some open fields and walk directly to the park. If we apply Pythagoras's theorem to calculate the distance you will get:

2) **Buying a Suitcase:** Mr. Harry wants to purchase a suitcase. The shopkeeper tells Mr. Harry that he has a 30-inch of suitcase available at present and the height of the suitcase is 18 inches. Calculate the actual length of the suitcase for Mr. Harry using Pythagoras' theorem. It is calculated this way:

3) **What Size TV Should You Buy?** Mr. James saw an advertisement of a T.V.in the newspaper where it is mentioned that the T.V. is 16 inches high and 14 inches wide. Calculate the diagonal length of its screen for Mr. James. By using Pythagoras' theorem, it can be calculated as:

4) **Finding the Right Sized Computer:** Mary wants to get a computer monitor for her desk, which can hold a 22-inch monitor. She has found a monitor 16 inches wide and 10 inches high. Will the computer fit into Mary's cabin? Use Pythagoras' theorem to find out:

Pythagorean Theorem Ramp Project Practice

Application of The Pythagorean Theorem

Handicap ramps, which is the application on which this lesson focuses, and skateboarding ramps are just a few examples of where the Pythagorean Theorem can be used. According to the Americans with Disabilities Act (ADA), every work place, private or public, must make their place of business handicap accessible. This activity focuses on the understanding of mathematical ideas and problem solving, in accordance with the NCTM standards.

Materials/Resources for Practice Ramp

- rubric
- tape measures
- construction paper or cardboard
- masking and scotch tape
- scissors
- some push pins
- calculators
- at least five objects in the classroom against which a ramp can be built

Procedure: (30 - 35 min.)

1. Divide the class into groups of three or four, depending on space. Groups should be organized before the activity starts. It saves critical time.
2. Give each group a copy of the rubric. Explain to the students that their grade depends on their performance on the task.
3. Explain to the students what they will be doing. Each group will have to measure the height of the object they have been assigned. (bookcase, table, desk, windowsill, file cabinet, etc.)
4. Then, to save some more time and to make the results more predictable, tell the students that the base of their ramp is already measured out for them. I did this with some masking tape before class. Each base was five feet.
5. Once the students have these two measurements, they can figure out the actual length of the ramp.
6. Once they have calculated the length of the ramp, they can begin construction. Part of the grade depends on accuracy and neatness of finished ramp. Encourage students to work cooperatively and independently. Assistance from the teacher will result in a lower the grade.

7. When the students have the ramp put together, they can attach it to the object. This is where the accuracy of their measurements and calculations comes into play. If the ramp doesn't reach from the top of the object to the piece of masking tape on the floor, which measures five feet, their calculations or measurements must have been off. Accuracy and neatness are accounted for on the rubric.
8. When the students have finished with their construction and are satisfied with their results, they must sit down as a group and decide on their anticipated grade according to the rubric. Then they must mark the rubric with the appropriate grade and turn it in to the teacher.

The Pythagorean Theorem - Rubric for Ramps

Team Members:

_____

_____

Requirements to be Assessed	Pts.	Anticipated Mark	Actual Mark
Accuracy and Neatness -of product -of measurements -of calculations Teamwork -ability to work with others -everyone contributed			
Teamwork -divided task evenly -not just one person **Independent of teacher** **Tone and Volume** -talked in regular voices **Completion of Task** **Accuracy** -product is mostly accurate -measurements and calculations are within a 5 % -needed my help a couple of times	**4**		
Teamwork- -could have split up task better -one person doing a little more **Independent of teacher** -needed teachers help...? **Tone and Volume** -voices were a bit too loud **Completion of task-** -needed about 10 minutes to finish **Accuracy-** -product wasn't very accurate -calculations and measurements about 10% off	**3**		
Teamwork - task not divided up evenly -one person doing a majority **Independent of teacher** -needed teacher's help more than 5 times **Tone and Volume** -voices too loud for classroom **Completion of task-** -incomplete even after extra time was given **Accuracy-** -product wasn't very accurate	**2**		
None of the above, but some portion of the project was done.	**1**		

Lesson #2: Building a Ramp Project (10 Days)

Objectives

Students will be able to...

- Determine the distance between two points on a coordinate plane using the Pythagorean theorem.
- Analyze given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution.
- Apply mathematics to problems arising in everyday life, society, and the workplace.
- Work cooperatively with others

Common Core Standards

LS 11-12.6
RSIT 11-12.2
RLST 11-12.2
Writing 9-10.5
Problem Solving/Critical Thinking 5.4
Health and Safety 6.2, 6.3, 6.6, 6.12
Responsibility and Leadership 7.4, 9.3
CCSS.MATH.PRACTICE.MP6
CCSS.MATH.PRACTICE.MP2
CCSS.MATH.PRACTICE.MP1
Residential and Commercial Construction Pathway D2.1, D2.2, D3.1, D3.7

Materials

Ramp to ADA Guidelines Handout
Bill of Materials
Granny on The Ramp Guidelines Handout
Self-Evaluation
Project Rubric

Lesson Sequence

- Pass out the ***Ramp to ADA guidelines Handout*** and the ***Granny on the Ramp Guidelines Handout***. Review as a class. Answer any questions as needed.
- Support students with filling out their ***Bill of Materials.***
- Support students as needed while they work in groups to create and build their ADA ramp.
- When project is finished have students place their finished products out and walk around the room to look at each other's projects.
- Have students complete the ***Self-Evaluation*** and use ***Project Rubric*** to grade student's ADA ramps.

Assessment

Perform informal observations through questioning and observing student's teamwork while building their ramps.

Use rubric to grade student's final ramp project.

Accommodations/Modifications

Strategic Partners
One on One Support
Extra Time If Needed
Calculators
Visuals When Needed

Ramp to ADA Guidelines Handout

Building a Stand-Alone Ramp to ADA Guidelines

Objective:

Putting the concepts of slope and the Pythagorean Theorem to use in the real-world context of building a ramp for handicap access to a building.

You will demonstrate your understanding of how the concept of slope is applied to the real-world construction of a wheelchair access ramp. You will use the Pythagorean Theorem to calculate the length of the ramp surface based on the acceptable slope of the ramp as defined by the Americans with Disabilities Act guidelines.

Safety:

The steeper the slope, the easier it is to slip or trip. It most likely won't be you (as you built it and know its pitfalls) but someone else will.

The steepest slope for a public ramp is one in twelve (1:12), which is governed by ease of use for wheelchair users. For use by the general public many building codes recommend a maximum slope of 1:8 (that is one-inch rise for every eight inches horizontally.) With a 1:8 slope, if the floor is nine inches above the ground, the ramp will be 72 inches long (1.83m long).

Complete a Bill of Materials:

Use the DIY Ramps plans to create your materials list.

Granny on the Ramp Guidelines Handout

Objectives:

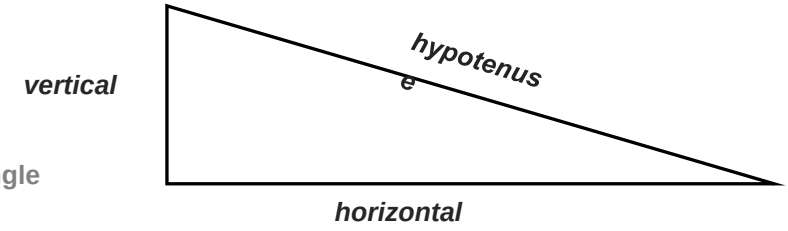
- Identify ***rise***, ***run***, and ***ramp length***.
- Describe the relationships among ***rise***, ***run***, ***and slope***.
- Determine height, slope, and velocity.
- Describe the ***Americans with Disabilities Act (ADA)*** guidelines for ramps.
- Identify ramps that are compliant with ADA guidelines.
- Design a ramp according to ADA guidelines.

Activity Description:

Students identify the different parts of a ramp. They will learn about the accessibility issues that come into play when someone must use a wheelchair. **"Build a Better Ramp"** is the design challenge. Students will analyze various ramps around the school to determine if they meet ADA guidelines. For each ramp that does ***NOT*** meet ***ADA*** guidelines, explain what must be done to make the ramp compliant with the requirements for safe ramps.

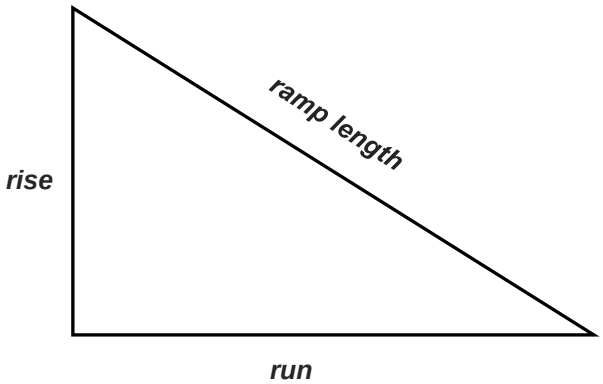
Background Knowledge:

As you already know, a ***right triangle*** consists of a ***vertical leg***, a ***horizontal leg***, and the ***hypotenuse***.

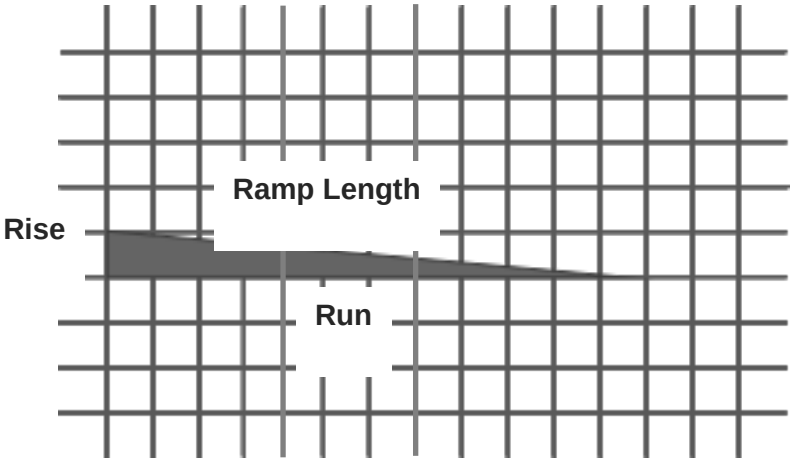


Parts of a Right Triangle

A ***ramp*** is an inclined surface that connects areas of different heights. The right triangle ***above is*** just like a ramp, although the parts of a ramp have different names. The part of a triangle that is called the vertical leg is called the ***rise*** of a ramp. The part of a triangle that is called the horizontal leg is called the ***run*** of a ramp. The ***hypotenuse*** of a triangle is like the length of the inclined surface of a ramp. In this activity, we will call this the ***ramp length***.



Parts of a Ramp



Slope of a Ramp

Assume a ramp, has a ***rise*** of 1 space and a ***run*** of 12 spaces. A ***ratio*** is a relation between two values in which one value is divided by the other. The ***ratio*** of the ***rise*** to the ***run*** of this ramp would be 1:12. There are several ways to express a ratio, and all of them are correct. The ratio can be expressed as 1:12; 1 *to* 12; or $^{1}/_{12}$.

The ratio of rise: run is called the *slope*. The slope of a ramp is an indicator of the steepness of the ramp. In the ramp above with its slope of 1:12, there is a rise of 1 box for every 12 boxes of run.

$$\textbf{Slope} = \text{Rise-Run} = \frac{\text{Rise}}{\text{Run}}$$

The *Americans with Disabilities Act (ADA)* is a civil rights law that was created in 1990 to provide protections against discrimination towards those in the community who have disabilities. The ADA states that **"an individual is considered to have a 'disability' if she/he has a physical or mental impairment that substantially limits one or more major life activities, has a record of such an impairment, or is regarded as having such an impairment."** Thus, this law applies to persons with seeing, hearing, speaking, walking, breathing impairments, and those persons whose impairments may interfere with performing manual tasks, learning, caring for oneself, and working. The law also protects those persons who **"have a known association or relationship with an individual with a disability."**

The ADA law provides for equal opportunities in a work environment and ensures access to public facilities (such as hotels, restaurants, theaters, auditoriums, stores, services, museums, recreational areas, and schools), transportation systems, and telecommunications. Some people with disabilities may need to use a wheelchair or other devices to get around in the community and in their homes. The ADA describes guidelines to reduce architectural barriers that can prevent a disabled person from having full access to the things they, like anyone else, may need in a community.

The law contains rules for new construction and modifications to existing structures so that public facilities are as barrier- free as possible. Some of the ADA guidelines talk about removing barriers (ADA Section 36. 604) with the priority being to install interior and/or exterior pedestrian ramps. Other portions of the ADA provide directions for building ramps or using existing space as ramps.

Some of these guidelines follow:

4. 8. 2 Slope and Rise

The *least possible slope* shall be used for every ramp. The *maximum slope* of a ramp in new construction shall be 1:12. The maximum rise for any run shall be 30 in (760 mm)

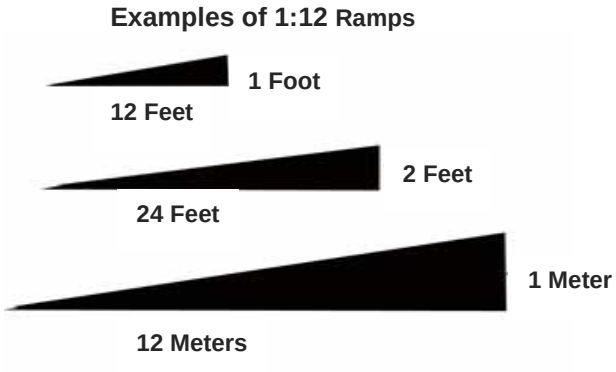
4. 8. 3 Clear Width

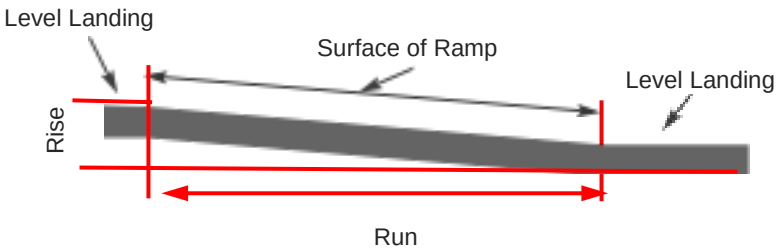
The minimum clear width of a ramp shall be *36 in (915 mm)*.

4. 8. 4 Landings

Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:

1. The landing shall be at least as wide as the ramp run leading to it.
2. The landing length shall be a minimum of 60 in (1525 mm) clear.
3. If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).





Components of a Single Ramp Run

You may work with a partner, but each person needs to hand in their own paper.

Using a ruler and graph paper, ACCURATELY DRAW (this means that one box on the graph paper = one unit) the following triangles.

1. DRAW a triangle that shows a slope of 1:20 (this is the same as 1/20). Label the rise of this slope triangle as side **a**. Label the run of this slope triangle as side **b**.

2. DRAW a triangle that shows a slope of 1:16 (this is the same as 1/16). Label the rise of this slope triangle as side **a**. Label the run of this slope triangle as side **b**.

3. DRAW a triangle that shows a slope of 1:12 (this is the same as 1/12). Label the rise of this slope triangle as side **a**. Label the run of this slope triangle as side **b**.

4. Which triangle appears to be the "steepest"? Explain why this triangle is the steepest on your drawing.

5. What ratio of side lengths (using the letters a and b) determines the slope of the ramp?

6. What does a slope of 1:12 mean in terms of the relationship between the ramp height and the ramp run?

7. Using the Pythagorean Theorem, find the deck length or ramp surface for each of the slope triangles you have drawn. Give the ramp surface dimension in inches.

The Pythagorean Theorem - Rubric for Ramps

Team Members:

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_____

Requirements to be Assessed	Pts.	Anticipated Mark	Actual Mark
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None of the above, but some portion of the project was done.	**1**		

Building a Ramp Project Self-Evaluation

1. What I had learned from this project ...

2. Parts of the project I am most proud of ...

3. Safety practices I have been observing...

4. What I have learned that I should be doing, from this point on, to ensure any other projects have an excellent outcome.

Bill of Materials

Part #	Description	Material Type	Dimensions (calculate footage)		Footage (bd/ft, lin/ft, sq./ft)	Quantity Of Parts	Unit Cost	Total Cost
				=				$-
				=				-
				=				-
				=				-
				=				-
				=				-
				=				-
				=				-
				=				-

To calculate board feet with all measurements in inches: T x W x L / 144

Total Cost: $-