Lesson 4: Tiling a Floor

PREREQUISITE ASSUMPTIONS

Before beginning this lesson, students should

- Know that a right angle is a 90 degree angle
- Know that their framing square can be used to confirm/make a right angle

COMPETENCIES

From Unit 1-Use of Scientific Calculator

A. Perform basic mathematical operations

> A.5. you perform exponentiation to powers of 2 and 3 applied to whole numbers
>
> A.11. you use a scientific calculator to compute expressions that involve addition, subtraction, multiplication, division, exponentiation to powers of 2 and 3 or combinations of these according to the standard order of operation rules

B. Apply basic mathematical operations in solving word problems

> B.1. you translate a verbally stated problem into performing an equivalent computation
>
> B.2. you interpret the computed answer to a word problem
>
> B.3. you check the reasonableness of a computed answer to a word problem

Unit 3. Decimal Fractions

A. Perform basic mathematical operations with decimal numbers

> A.2 you round decimal numbers up or down to 2 decimal places of accuracy
>
> A.8. you use a scientific calculator to compute expressions that involve addition, subtraction, multiplication, division, exponentiation to powers of 2 and 3, square root taking or combinations of these with decimal numbers according to the standard order of operations

Unit 4. Percent Problems

A. Perform basic mathematical operations with numbers expressed as percents

> A.3. you use a scientific calculator to compute the answer to percent problems

Unit 5. Measurement

A. Perform calculations with quantities having units of measure: inches, inches squared, inches cubed, feet, feet squared and feet cubed only.

> A.1. you perform addition, subtraction, multiplication, division, exponentiation to powers of 2 and 3, square root taking or combinations of these operations for quantities expressed as measurements
>
> A.2. you expresses the answer with the appropriate units
>
> A.3. you use a scientific calculator to compute the answer to problems involving measured quantities
>
> B.3. you convert area measurements to different square and cubic units of length measure

Unit 6. Applied Plane Geometry

D. Calculate perimeters and areas of closed planar figures

> D.1. you compute (given sufficient data) the perimeters and areas of rectangles
>
> D.2. you compute (given sufficient data) the perimeters and areas of triangles
>
> D.4. you compute (given sufficient data) the perimeters and areas of trapezoids
>
> D.7. you compute the area of a circle given its radius or diameter

Lesson 4: Tiling a Floor

Notes to Self

- One thing I want to do during this lesson ….

- One thing I want to pay attention in my students' thinking …

- One connection or idea I want to remember …

Suggested Timeline

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
3 minutes	Question 1	Small groups
2 minutes	Capture answers from #1	Whole class
10 minutes	Question 2 and 3	Whole class and Small groups
5 minutes	Discuss 2 and 3	Whole class
12 minutes	Questions 4 - 6	Small groups
12 minutes	Discuss Questions 4 - 6	Whole class and instructor led
15 minutes	Questions 7 - 11	Small groups
10 minutes	Discuss Questions 7 - 11	Whole class
8 minutes	Questions 12 and 13	Small groups
8 minutes	Discussion 12 and 13	Whole class and instructor led
10 minutes	Questions 15 and 16	Small groups
5 minutes	Discussion 15 and 16	Whole class
5 minutes	Making connections	Instructor led

SPECIFIC OBJECTIVES

Students will understand that
- The area of a rectangle is calculated as length x width.
- Area has units of ft^2 or in^2
- Some computed answers need to be rounded to whole numbers large enough to make sure you don't wind up underestimating materials.
- The estimate of the cost of a job depends on many variables including the rate of pay, the cost of materials, and any overhead percentage you add to your estimates.

Lesson 4: Tiling a Floor

- Creating an estimate by rounding without using calculators can be an important time-saving skill on the job.

Students will be able to

- Use dimensions stated in feet and inches.
- Combine the use of addition and multiplication in computing a total amount.
- Use both computational and rounding-based (non-calculator) methods in obtaining an estimate.
- Obtain reasonable estimates of the labor and material costs of tiling a floor.
- Convert between square inches and square feet.
- Apply a percentage overhead charge to an estimate.
- Calculate areas of rectangles and other shapes.

Problem Situation #1: Tiling a Floor

You have been asked by the college to tile the student lounge in Building B. The college doesn't want to spend too much money, so they've decided to use 12" by 12" glue-on vinyl tiles in a checkerboard pattern for the floor. You need to determine an estimate of the total cost of the job (labor and materials).

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
3 minutes 2 minutes	Work on Question 1 Capture answers from #1	Small groups Whole class
Notes: Instructor tells students: "*no need to think about this individually, just start throwing out ideas to your group. I'm only giving you a couple of minutes for this question. Be sure that everyone writes down everything you come up with."*		

1. What information do you need to gather to determine the total cost (labor and materials) for the job?

Possible answers include:
*) cost of vinyl tiles
*) size of floor
*) labor fee
*) how long to lay each tile
*) # of tiles we will need
*) gonna include overhead?
*) increments the tiles are sold in
*) 'cut' tiles (fractions of tiles)
*) deadline
*) what materials are needed?
*) cost of glue

Lesson 4: Tiling a Floor

> NEED: area of the floor, price of the tiles and glue
> AND standard per square foot to charge
>
> After sharing out, Instructor tells students – "***let's just focus on the tiles and glue for materials. I'll give you specifics a little later in the lesson.*** "

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
10 minutes work 5 minutes discuss	Question 2 and 3 Discuss 2 and 3	Small groups Whole class

Notes: This problem situation is another where students are estimating and calculating areas. The goal of the questions in this section is to model a realistic process for determining the cost of the job. This is also the first lesson where students are asked to add 10% so, in the discussion, extra time needs to be spent making sure all students understand the math being done.

Announce: ***"The first thing we are going to do is to estimate the area of the student lounge. We are going to start with having a class discussion in the lounge to come up with strategies to estimate. Choose one person in your group to write down your estimate. That person will need to bring a pencil or pen. Everyone else leave all your stuff here."***

Give the groups a few seconds to select the recorder and give that person the scale drawing of the lounge (blank except for the rectangle on the paper).

Walk to the lounge with the students and then facilitate a discussion about what strategies are possible for estimating the area.
Key point:
- Make sure a student points out that they estimate the area by figuring out the length and width of the room and then calculating the area. If it isn't brought out, be sure to point out that they are actually using the formula for area of a rectangle: A = LxW

Have students return to the room when the group they are working with is done with their estimate and have them write out their answer to question 2 and also do question 3. Make sure students know to NOT return to the lounge to measure until everyone is back in the room.

As a class, you will now walk over to the student lounge and discuss strategies to estimate the area of the lounge. Wait for complete instructions from the instructor.

2. In the space below, write down your estimate for the area of the room, the strategy that you chose to use, and why you picked that strategy. If you needed to do any calculations, be sure to also show them below.

Lesson 4: Tiling a Floor

Answer: most students should end up with a room size estimate around 20' x 20'
So: 20' x 20' = 400 square feet

Possible strategies:
- If it isn't volunteered, can tell students that the ceiling tiles are 2' x 2'. Use them to determine length and width
  - Maybe ask why you wouldn't just count all the tiles (too many)
- Use the current floor tiles (they are 1' x 1')
- Pace out the room
  - This method leads to lots of error and isn't recommended for such a small room
  - Maybe if all 4 people in the group did it then it would lessen the error...
- Use pieces of furniture as benchmarks.
- 'eyeball it' based on rooms they are familiar with
  - Maybe they know the dimensions of the shed and they can relate that to the lounge

Allow students to listen to all the methods and encourage them to use one that makes the most sense to them. During the share out in the classroom, ask groups to call out their estimates. Pick one to explain their strategy, then ask the class if another group had a different strategy and have them share it.

FYI (do NOT share this with the students)...
the dimensions of the student lounge are 18'-11 ¾" x 19'-5 3/8"

---

3. Use your area estimate from #2 to calculate how much you will charge in labor for the job. Note, you charge $5.75 per square foot for this type of work.

Answer: 400 sq ft x $5.75/sq ft = $2,300

It is possible that students will estimate the labor charge as 400 x $6 = $2,400. This isn't wrong since they will be recalculating the labor charge anyway once they have the actual measurements.

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
12 minutes 12 minutes	Work on Question 4 - 6 Discuss 4 - 6	Small groups Whole class

Notes: Allow some groups to start on #4 before everyone is done with #3 just to keep the crowd down in the student lounge. This part now asks students to use real measurements to calculate the labor

Lesson 4: Tiling a Floor

costs. It also introduces adding 10% to the cost. They haven't done this before, so time needs to be spent on this process to make sure they understand how to do it.

Give every student the scale drawing of the lounge.

Announce: **"You'll now need to go back to the student lounge to measure the actual dimensions of the room. Every student needs to take the measurements and then compare with your group to make sure they all match. Please measure using feet and inches on your tape measure and measure to the nearest 1/8 of an inch."**

Also point out that some of the math that they will be doing is stuff that I haven't specifically taught them yet. Just work together and do the best you can on #6.

4. Now, go back to the student lounge and take measurements. Put your measurements on the lounge drawing provided by your instructor (be sure to include units). Measure in feet and inches and measure to the nearest eighth of an inch.

Answer:
18'-11 ¾" x 19'-5 3/8"

5. Update your calculation for how much you will charge for labor using the actual measurements of the lounge. Show your calculation below and include units in your answer.

Answer:
18'-11 ¾" x 19'-5 3/8" = 369.1053 square feet

Round up to 370 square feet to determine the labor cost.
370 square ft x $5.75/sq ft = $2127.50

During the discussion talk about why we would round 369.1 UP to 370.

Take Away:
Demonstrate rounding techniques by drawing a number line and show how, typically you round to the number that is closer. BUT, in construction, you need to make sure you have enough materials, so you need to *think* about the situation and almost always, you round up.

6. Standard practice is to add 10% to the cost for the job to account for 'overhead.' So, take your answer from question 5 and determine how much you'll actually charge for labor. Round your answer to one decimal place. Show your work below.

Lesson 4: Tiling a Floor

Answer: $2127.50 * 1.1 = $2340.25 rounds to $2340.30

First instance with percent. Take a temperature of the room on their experience with percent.
Have a student that calculated it as *10% then add to original explain their work first. Have them
demonstrate or explain how to do it on the calculator.
Show that 10% on the calculator is 0.1

Take away:
Don't do a mini % lesson here. That will happen in Lesson 7. Spend time instead helping students with
their number sense around 10%

Finish up by asking if anyone knows how to figure out 10% without a calculator. Have them explain
the process.

Somewhere in there, make sure students know that 10% is 10 divided by 100 (per cent means
divided by 100)

Finally, point out (or see if a student notices) how close this number is to the estimate they did in
question #3. So, the estimate helps you know you didn't make a mistake in your calculation. It helps
determine that your answer is *reasonable.*

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
15 minutes 10 minutes	Work on Question 7 - 11 Discuss 7 - 11	Small groups Whole class

Notes: Since we have discussed rounding and % in questions 4 – 6, these questions should not take as
much time. Except #7... that one has students divide by the area of the tiles and, if they don't do that
properly, they will get the wrong answer.

Be sure to cruise the room to see what strategies the students use on #7a. Hopefully there will be
multiple strategies. Ask students to put their work on the board with the different methods to lead
into the discussion about converting units in 7a.

After 7, allow students to lead most of the whole class discussion. Interjecting to help make sure
things are clear and connecting with the work in #4-6

7. Calculate the amount of materials you need to order:
    a. If the glue-on vinyl tiles come in boxes of 24 tiles calculate the number of boxes of tile
        you need to order for this job.
    b. If one gallon of adhesive covers 190 square feet of floor, calculate how many gallons you
        need to order for this job.

Lesson 4: Tiling a Floor

> Answer:
> Tile: 370 square feet / 24 square feet = 15.41667 boxes... round up to 16 boxes
> Glue: 370 sq. Ft / 190 sq. Ft = 1.947368 gallons of adhesive, so 2 gallons <--- come back to this when we talk about 10% 'buffer' and how it's a good idea to buy a 3rd gallon and keep the receipt just in case.
>
> **Take Away:**
> - Draw the tile with 12" x 12" sides and ask the students the area in square inches
>   - Look around and see if anyone has 12 and anyone has 144
>   - Ask students to explain how they figure it out
> - Area units are important. If students used 12" x 12" tiles, the area of the tiles in inches is 144 sq inches.
> - The construction master calculator 'has your back' when it comes to units. Typically, you would have to convert square inches to square feet, but the calculator will do it for you.
> - Typically you also have to have all units 'match' when you calculate, but if I put my tile as 1' x 12" it will automatically convert them to the same units (demo) 1' x 12" = 1 sq ft. then hit 'inch' to show that it will convert to 144 sq inches.

8. Standard practice for construction work is to add 10% to the amount of materials you order to ensure you have enough on hand to complete the job. So, take your answers from question 7 and determine how much tile and glue you need to order.

> **Answers:** 16 * 1.1 = 17.6 so round up to 18 boxes
> 2 * 1.1 = 2.2 so round up to 3 gallons
>
> Note: typically, the 10% is added to the rounded up numbers, not the actuals. So, a little more of a buffer.

9. The wholesale price of the tile is $15.60 per box and the glue is $15.00 per gallon. Determine the total cost for materials for this job.

> **Answer:** $325.80
>
> Price of tiles = 18 boxes x $15.60 per box = $280.80
> Glue: $15.00 x 3 = $45.00
> Total materials cost = 280.8 + 45 = $325.80

10. Again, standard practice is to add 10% to the cost for the job to account for 'overhead.' So, take your total material costs (answer from question 9) and determine how much you'll actually charge for materials. Round your answer to one decimal place. Show your work below.

> **Answer:** $325.80 * 1.10 = $358.38 round to $358.40

Lesson 4: Tiling a Floor

11. Finally, determine the price (labor and materials) you will quote the College. Show your work below and include units in your answer.

> **Answer**: $358.40 + $2340.30 = $2,698.70
>
> If students are stuck, remind them that they already did all the calculations, they just need to add together their answers from #10 and #6

Problem Situation #2: Determining your Price

As stated earlier in the lesson, standard practice is to add 10% to the total cost for a construction job to account for 'overhead.' You did this by calculating the total labor cost and the total material costs separately and then adding them together.

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
8 minutes 8 minutes	Work on Question 12 - 14 Discuss 12 - 14	Small groups Whole class

Notes: This section is to help students make connections with multiple methods to solve problems. Specifically A*110% + B*110% = (A+B)*110%

This is the distributive property.
Point out that students also used the commutative property earlier when they added in a different order (glue + tile or tile + glue)

They use properties of math all the time and don't realize they are doing it. We use these properties to make our lives easier and possibly do things quicker. There is almost always more than one way to solve something, so don't doubt yourself if you have a different strategy that someone in your group.

Be sure to cruise the room to make sure people are actually predicting for #12 before moving on to #13. If they don't know, tell them to guess!

12. **Predict** if you will get the same final price as you did in #11 if you instead add the labor and material costs together *first* and *then add* the 10% overhead to that total. State Yes or No and explain your reasoning.

13. Now, *do the calculation*. Add 10% overhead to your total costs using your answers from questions #5 and #9. Round your answer to one decimal place. Show your work below.

Lesson 4: Tiling a Floor

Answer: $2698.60
Labor (#5): 370 square ft x $5.75/sq ft = $2127.50
Materials (#9): Price of tiles = 18 boxes x $15.60 per box = $280.80
Glue: $15.00 x 3 = $45.00
Total materials cost = 280.8 + 45 = $325.80

Total = $2127.50 + 325.80 = $2453.30

10% overhead = on CM5 calculator: 10 % x $2453.30 = $245.33
Calculated Charge = $2453.30 + 245.33 = $2698.63 round to $2698.60
 (NOTE: most contractors add 10% to their bid as an overhead charge to cover materials runs, wear and tear on tools, phone calls and emails, etc.)

14. Do your answers to question #11 and #13 match? Why or why not?

Answer: The answer in #13 is 10 cents less than the answer in #11. That is because 11 had the labor rounded and the materials rounded and then the two were added, where in #13, the rounding happened after they were added together. WHEN you round matters.

Take aways:
- When you round matters. Typically we only round at the very end unless there is a reason to round earlier because it makes a difference in the answer
  - Reasons include: estimating (round first), only whole gallons (round in the middle)
- It didn't make a difference which calculation method was used. EITHER method can be used to determine the total. You can add the 10% to each piece, or add the 10% to the final number.

Ask students WHY.
- If no one knows/can clearly explain, talk about the math demonstrating with parentheses and lead into the language about the distributive property

Problem Situation #3: Rooms come in many shapes

In this, and other lessons, you have found the area of shapes that are all based on a rectangle. When you found the area of those shapes, you used the formula for the area of a rectangle. What happens when you get to a room/house/building that is a different shape? Work with your group to use the formulas provided below to calculate the area of the shapes given.
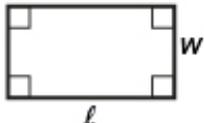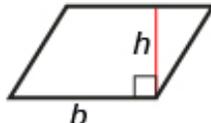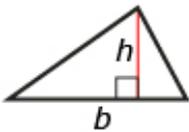
Lesson 4: Tiling a Floor

Square
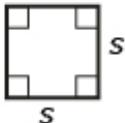
$$A = s^2$$

Rectangle

$$A = \ell \times w$$
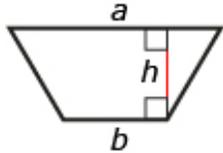
Parallelogram

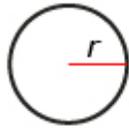$$A = b \times h$$

Triangle

$$A = \frac{1}{2} \times b \times h$$

Trapezoid

$$A = \frac{(a+b)}{2} \times h$$

Circle

$$A = \pi \times r^2$$

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
10 minutes 5 minutes	Work on Question 15 - 16 Discuss 15 - 16	Small groups Whole class

Notes: This section is to give students in class practice working with shapes different that rectangles

Cruise the room and help the students interpret the formulas if necessary.

Have students put their work on the white boards for both problems and let the students explain how they found the answers during the discussion time.

If some students finish early, make sure they help the students in their group. Send a savvy student to another group to help them if necessary.
If an entire group is done early and nobody else needs help, let them start on the homework while they wait for people to finish.

15. What is the area of the patio shown in the picture below. Be sure to show your work and include units in your answer.
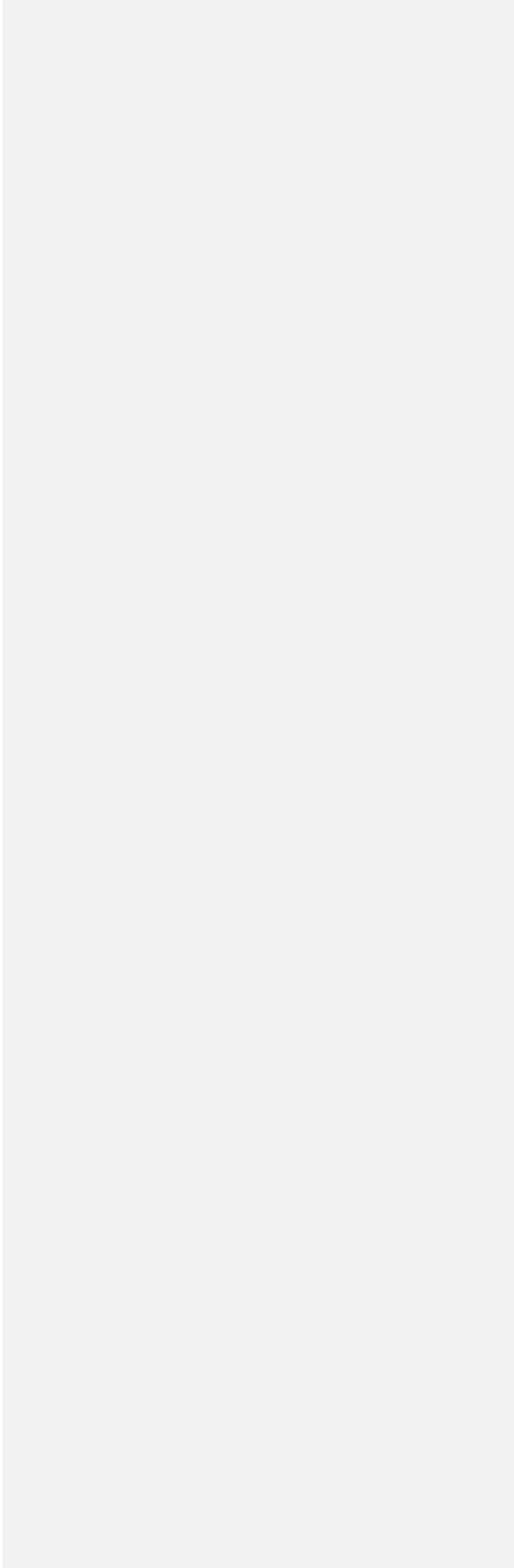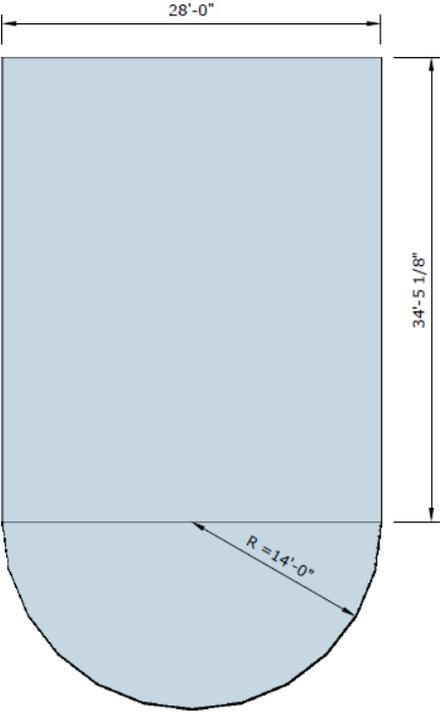
Lesson 4: Tiling a Floor

Scale:

⊢―⊣

1 foot

Patio

Grill
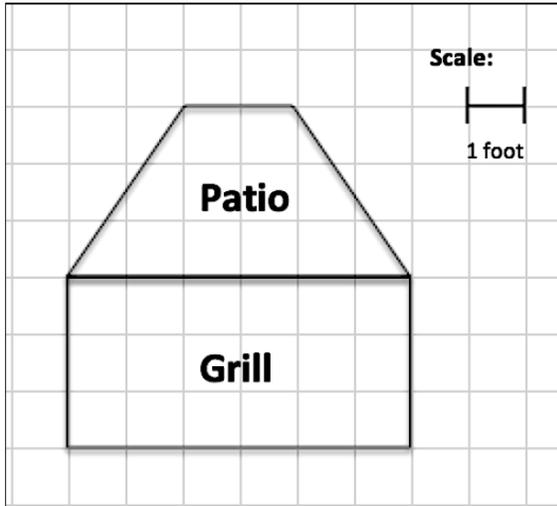
Answer: a = 6, b = 2, h = 3. Using the formula: Area = (6+2)/2 * 3... 4*3 = 12 square feet

They also could have found the answer by moving the triangles around and counting squares since each square is one square foot.

16. You have been hired to to build a house with the crazy shape shown below. Calculate the area of floor.

Lesson 4: Tiling a Floor

28'-0"

34'-5 1/8"

R = 14'-0"

Lesson 4: Tiling a Floor

> **Answer:** 648 square feet
>
> Rectangle area = 24' x 22' = 528 square feet
> Triangle area: ½ base x height. Base = 24', height = 10'. Area = 24 x 10 x ½ = 120 square feet
> Total area = 648 square feet

MAKING CONNECTIONS

Record the important mathematical ideas from the discussion.

- Convert a % to a decimal by dividing by 100 (move the decimal two places to the left)
- Adding 10% is the same as multiplying by 110%
- Round up when estimating for construction
- Decent estimates can be gotten using a known reference
- Areas of shapes are found using formulas
    - Area of a rectangle is length x width
    - You can always look up a formula

PRACTICE

Pg 85   1, 4, 7, 10

Pg 87   22

PG 101 2

PG 103 12

Pg 86 15. You have been asked to give a price for the shingling job shown. The homeowner just wants a rough idea of the cost of this job.

1. Without using a calculator, estimate the square feet of roof covered.
2. You charge $1.85/sq ft for simple shingling jobs such as this. Again, without using your calculator, give a rough estimate of the cost of this job. Your estimate should be on the high

Lesson 4: Tiling a Floor

side because it's always better to estimate high and charge less than to estimate low and charge more.

3. Time to get back to office and write up the proposal.
    a. Calculate the square footage of the roof. (Round you answer to the square foot.)
    b. How much will you charge the customer? (Round to the nearest dollar.)
    c. Now add 10% to the price you found in b. to cover overhead.
    d. Finally, determine how many bundles of shingles you should order if each bundle covers 33 sq ft of the roof.

4. You have been hired to to build a house with the crazy shape shown below. Calculate the area of floor.

24'-0"

32'-0"

22'-0"
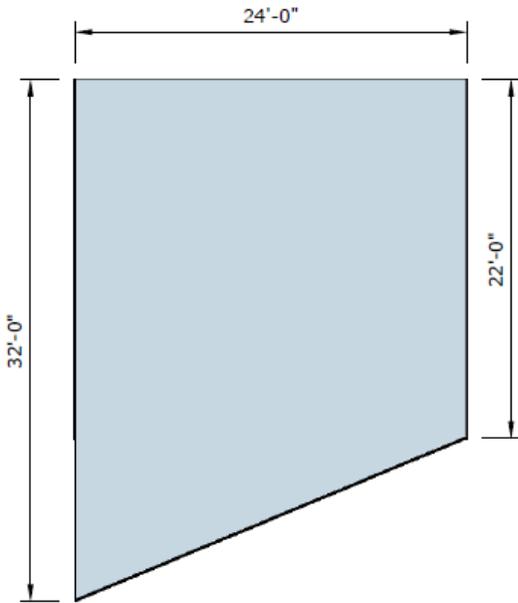
Pg 121 2

Pg 122 5

Lesson 4: Tiling a Floor