Lesson 2: Measuring Wood Blocks and Planning a Bathroom

PREREQUISITE ASSUMPTIONS

Before beginning this lesson, students should

- Already have assigned groups - have at least one mathematically capable person in each group.
- Have tape measures
- Have a copy of the textbook
- Have some basic knowledge of using a tape measures

Competencies covered in the lesson and associated homework

Students will be able to:

From Unit 1-Use of Scientific Calculator

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

From Unit 2- Fractions

A. Perform basic mathematical operations with fractions with construction-friendly denominators

A.1. you determine if fractions are equivalent

A.2. you compare the magnitude of different fractions

A.3. you express improper fractions as mixed numbers and vice versa

A.4. you reduce fractions to lowest terms

A4.5 you add and subtract fractions without a calculator

B. Use fractions in solving word problems

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B.1. you translate a verbally stated problem into performing an equivalent computation involving fractions

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 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

Notes to Self

- One thing I want to do during this lesson ….
- One thing I want to pay attention in my students' thinking...

  Do they come to the lesson with knowledge of adding fractions and mixed numbers?
  Do they know how to ask for help inside their group?
- One connection or idea I want to remember is ...

Suggested Timeline

Duration	**Activity** (Indicate question number)	**Suggested Structure** (Indicate group, whole class or individual work)
18 minutes	Questions 1-8	Individual and Groups
12 minutes	Discussion on 1-8	Whole Class
12 minutes	Questions 9 - 13	Individual and Groups
5 minutes	Discussion on 9-13	Whole Class

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5 minutes	Construction master demo	Instructor Led
12 minutes	Questions 14 - 15	Groups
12 minutes	Discussion on 14-15	Whole Class
5 minutes	Making Connections	Whole Class

SPECIFIC OBJECTIVES

Use addition and subtraction of fractions and accurate tape measure skills to find sums and differences of materials' measurements.

By the end of this lesson you will understand that...

- Fractions contain a numerator and a denominator
- The numerator is the top number in the fraction, the denominator, the bottom number.
- Adding and subtracting fractions requires finding a common denominator
- Mixed numbers consist of a whole number added to a fraction
- There are at least two ways to add and subtract mixed numbers

By the end of this lesson you will be able to...

- Correctly add and subtract fractions with different denominators
- Correctly add and subtract mixed numbers

Each group of 4 students is given 4 lengths of 2x6 cut so that one is an exact 1/2 inch length, one is a 1/4 inch length, one a 1/8 inch length and one a 1/16 inch length. (i.e. 7 1/2, 9 3/4, 5 7/8, 3 3/16). The four wood blocks are labeled with tape A, B, C and D.

Problem Situation #1: Measuring Wood Blocks

Duration	**Activity** (Indicate question number)	**Suggested Structure** (Indicate group, whole class or individual work)
18 minutes work 12 minutes discuss	Questions 1-8	Individual and Groups Class discussion
Notes: The point of the first problem situation is to give the students a chance to practice measuring accurately, and have them work with adding fractions and mixed numbers without a calculator. It also is to help them (again) learn the benefits of working in a group. Getting the students to work together to help each other through this problem with both the measuring and the calculating is extremely important. Instructions to announce to students as you hand out the sets of blocks:		

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Please put your calculators away and take out your tape measures. You will be measuring the blocks I am giving you and then doing some addition and subtraction by hand. Though much of the work is to be done individually, it is also important for you to check your work with the other students in your group.

While the students are working, cruise the room. Some students will have no trouble measuring or adding, others will have lots of trouble. Encourage the students that don't have trouble to work with the struggling students. Resist the temptation to tell students how to do the work. If a student asks for help, respond by asking if they have asked the other students at their table for help first. (*more tips for facilitating are provided in the facilitation tips document*).

As students complete #3, look for 2 - 3 different strategies for completing the addition. Ask those students to put their work on the white board and ask them if they are comfortable explaining what they did. If they aren't, then, when it comes time to discuss, the instructor can explain the student's work.

As you know, being able to measure accurately is an important skill for any carpenter or construction worker. This lesson gives you a chance to practice your measuring skills.

1. On your own, measure each block and fill in their lengths in the table below. Be sure to include units.

Block	**A**	**B**	**C**	**D**
Length				

Answer:

Block	**A**	**B**	**C**	**D**
Length	**7 ½"**	**9 ¾"**	**5 7/8”**	**3 3/16”**

2. Compare your measured lengths with those of your group mates. Do they match? If not, work together to determine the correct length of each block. Update your table if necessary.

3. Put the four blocks together end to end. On your own, <u>estimate</u> how long the total length of the blocks is (use visual cues in the room to help you come up with your estimate. Do *NOT* measure or calculate). Write your estimate below and then move on to Question 4.

The goal of this question is to get the students to think about how they can use their 'perceptual knowledge' to come up with a pretty good length estimate. During the discussion have students share their strategies.
Some possible strategies:

- A notebook is 11” long

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- The table is about 3 feet wide
- My forearm is about xx" long

4. Calculate the length of all four blocks (A + B + C + D). *Do not use a calculator* and show your work in the space below.

Answer: 26 5/16"
Be sure that the students have put their work on the board and explain their process to the class
Possible strategies:

- Could have written the fractions down as 16^{th} to begin with.
- Create common denominators
- Turn each mixed number into an improper fraction
- Add whole numbers first and the fractions with the ¼ and ½ together. Then convert to 1/16 to finish

5. If you finish before the others in your group, work with them until everyone in the group has finished problem #4.

6. Now, on your own, measure the total length of all four blocks. Write the measurement in the space below and be sure to include units.

Total Measured Length	

7. Compare your measured length in #6 with that of your group mates. Does it match? If not, work together to determine the correct total measured length. Update your answer in #6 if necessary.

8. Compare your measured length in #6 with your calculated length in #4. Does it match? Why or why not?

Problems 1 – 8 Take-aways:

- Precise measuring often requires you to measure the same thing more than once "measure twice, cut once."
- Estimating can involve rounding first and then doing some math, or it can involve using what you know in the world around you as a 'benchmark.' Both techniques are important skills for folks working in construction

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- Adding fractions requires creating 'common denominators' – explain this on the board by creating two pies. One cut into 4 pieces and one cut into 8 pieces and explain how fractions are telling us how many pieces (numerator) out of a pie cut into that many pieces (denominator)… so, to compare (add or subtract) fractions, we need each piece of pie to be the same size piece. Do ¼ + 3/8 on the board with the pie pieces as visual.
- Equivalent fractions and reducing fractions... how ½" and 8/16" are the same... draw that from the student work.
- When we talk in math about 'check your work.' You can do that by finding a number in more than one way. So, here, you checked your addition work by measuring the total length.

Possible practice problem for them to do if lots of students struggled:

- 3 5/8" + 4 ½" + 1 7/16" + 7 ¼" (answer is: 16 13/16")

Duration	**Activity** (Indicate question number)	**Suggested Structure** (Indicate group, whole class or individual work)
12 minutes work 5 minutes discuss	Questions 9-13	Individual and Groups Class discussion

Notes: This part is almost a duplicate of 1 – 8 above, instead it is a subtraction problem. Keep an eye out for students that struggled during the first part with the addition and make sure to be close by to get their groups to work with them, or , if someone is really struggling/frustrated, to jump in and help.

Instructions: ***this next set of questions will let you practice some subtraction by hand. As with the first part, though much of the work is to be done individually, it is also important for you to check your work, (and ask for help if you need it!) with the other students in your group.***

It is still important to make sure the math is written up on the board and addressed. But overall, spend significantly less time discussing this problem.

9. Calculate how much longer the longest block is than the shortest block. <u>*Do not use a calculator*</u> and show your work in the space below.

Answer: 6 9/16"

<u>Be sure that the students have put their work on the board and explain their process to the class</u>

Possible strategies:

- Create common denominators
- Turn each mixed number into an improper fraction
- 'Borrow' from a whole number and subtract fractions first and then subtract whole numbers to finish

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10. If you finish before the others in your group, work with them until everyone in the group has finished problem #9.

11. Put the longest and shortest blocks side by side (or on top of each other) and, on your own, measure the difference in length. Write the measurement in the space below.

Length difference between shortest and longest block	

12. Compare your measured length in #11 with that of your group mates. Does it match? If not, work together to determine the correct total measured length. Update your answer in #11 if necessary.

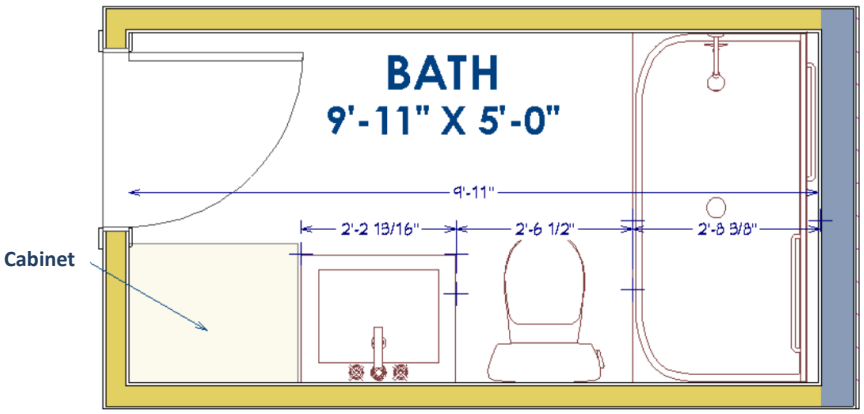
13. Compare your measured length in #11 with your calculated length in #9. Does it match? Why or why not?

Run through the addition and subtraction problems above with the Construction Master calculator as a demo.

- Addition problem from #4
- Subtraction problem from #9
- Maybe create a random problem with feet and inches

Be sure to tell students to put the calculator away for #14!!!!

Problem Situation #2: Planning out a bathroom



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You are working on renovating a bathroom and you are planning to install a new cabinet as shown in the image above.

Duration	**Activity** (Indicate question number)	**Suggested Structure** (Indicate group, whole class or individual work)
12 minutes work 12 minutes discuss	Questions 14-15	Groups Class discussion

Notes: The math on this problem is significantly more challenging because it is feet, inches and fractions of an inch. The students are also not told how to do the calculation. It may be necessary to provide guidance for students if they appear to be struggling with where to start.

Suggested facilitation ideas for #14:

- Tell students "***before you start doing any calculating in #14, first discuss with your group what strategy you will use to do the work***."
- If students are struggling
  - suggest students break the lengths into pieces (add all the feet together, then all the inches, then all the fractions of an inch) OR
  - suggest they convert the feet to inches for each of the pieces (though this may be too hard for many students without a calculator).
- Suggest students pull out their tape measures and see what 2' 6 ½" is on their tape measure (can use it to convert to all inches)
- If half the class or more find it too hard, convert the feet to inches for them and put the new numbers on the board for each part of the drawing and have them do the math with all inches.

Problem #15 requires students to use units in the construction master calculator. Encourage students to help each other with the calculator usage. When going over #15, be sure to show multiple ways to use the calculator by doing demonstrations of the calculations on the Doc Cam with the students following along.

14. *Without using a calculator*, calculate the maximum width of the cabinet you can install. Be sure to show your work and include units in your answer.

Answer: 2' 5 7/16"

Step 1: add the 3 lengths in pieces: 2' + 2' + 2' = 6'

2" + 6" +8" = 16" which is 1' 4"

13/16" + 8/16" + 6/16" = 27/16" which is 1 9/16"

So 6' + 1' + 4" + 1" + 9/16" = 7' 5 9/16"

Step 2: subtract the total from 9' 11"… first convert 11" into 10" and 16/16" then subtract each piece

16/16" – 9/16" = 7/16"

10" – 5" = 5"

Commented [SP2]: These were Lincoln's original questions for this part... 1) Given the sketch of this bathroom floor plan, what is the combined width of the shower, toilet, sink and vanity (including required clearances)?Hint: Pay close attention to the units! and 2) Will a cabinet that measures 2 feet 3 1/16 inches fit in the space to the left of the vanity? Are these better instead of #14?

Commented [CP3]: Before moving on to 9, I think students should have an opportunity to practice using the new found stategies to adding some mixed numbers. Otherwise, it could be too fast of a transition to subtraction. Some level of mastery of addition will help students feel more confident before try subtraction (which has more challenges).

Commented [CP4]: Again, I think students need some time to practice strategies for subtracting mixed numbers. One example, even one that is fully examined, is not enough to build confidence. Subtracting fractions with borrowing is confusing, and students must have time to try out these strategies without rushing to the next activity.

Commented [CP5]: Asking students to subtract with borrowing will take a good chunk of time. This is confusing for many students. How much time do we want to spend on hand calculations? If hand calculations are important, students need time and practice to master them. If they are not important, should had calculations be taught at all?

Commented [CP6]: Homework problems needed here.

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9’ – 7’ = 2’ Then put it all together: 2’ 5 7/16”

15. Now, *take out your calculator* and confirm your answer for #14 is correct. Write down exactly what you typed into your calculator in the space below (including units).

Answer: 9 foot 11 inch - 2 foot 2 inch 13/16 inch + 2 foot 6 inch ½ inch + 2 foot 8 inch 3/8 inch = **2’ 5 7/16”**

MAKING CONNECTIONS

Record the important mathematical ideas from the discussion

Question for students (direct each question to a different group):

What are the top and the bottom of a fraction called?

- Fractions contain a numerator and a denominator
- The numerator is the top number in the fraction, the denominator, the bottom number.

What does it mean to ‘find a common denominator’ and when/why do we do it?

- Adding and subtracting fractions requires finding a common denominator

How many different ways are there to add fractions?

- There are at least two ways to add and subtract mixed numbers

Why do we care so much about units in this class?

- Units tell us important information… it tells us if we are dealing with a length or an area or some other unit of measure.
- Units help make sure we are ‘comparing apples to apples’

Practice:

Pg 20 #1
Pg 21 #8
Pg 22 #19
Pg 22 # 25
Pg 23 #27 and 28

Pg 25 # 3
Pg 26 # 7
Pg 26 # 8
Pg 28 #17

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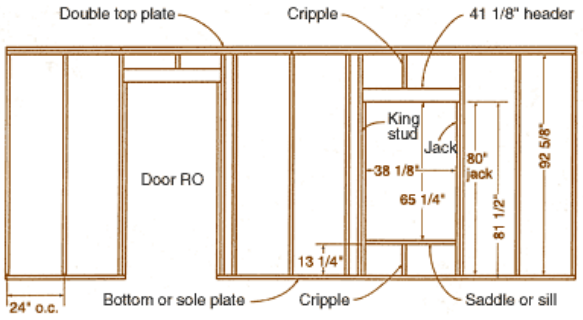
The drawing below shows a wall frame with a 38 1/8” x 65 ¼" window opening. How much smaller do you need to make the opening if the window you are installing is 36 3/16” x 62 3/8”, and you are required to leave a ½" gap between the window and the opening on each side?



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The following questions refer to the kitchen elevation shown below.

What is the width of the right upper cabinet?

If the window is centered between the upper cabinets as shown, how much wall space is there between the window and each wall cabinet?

What is the distance from the top of the wall cabinet to the ceiling?

What is the distance between the upper cabinets and the top of the lower cabinets?