

Calculate board feet = Apply and extend the properties of exponents to solve problems with rational exponents

Program Task: Order lumber by calculating the board feet needed.

Program Associated Vocabulary:

BOARD FEET, DEPTH, DIMENSION, ESTIMATE, FOOT, FRACTION, INCH, LINEAR FOOT, UNIT PRICE, WIDTH

Program Formulas and Procedures:

Lumber at saw mills is usually ordered by the board foot; the board foot is the unit of cost to purchase the material. A board foot is 1" thick, 12" wide and 12" long (1" × 12" × 12") or 144 cubic inches.

For example a piece of lumber 1" thick, 6" wide and 24" long equals one board foot.

Since length is measured in feet, to find out how many board feet there are in a piece of lumber use the following formula:

$$\frac{T \times W \times L}{12} = \text{board feet}$$

Find out the number of board feet in a board that is 2" thick, 4" wide and 16' long

$$\frac{2 \times 4 \times 16}{12} = \text{board feet}$$

$$\frac{128}{12} = \text{board feet} = 10 \frac{2}{3}$$

The cost per board ft. is \$.45. To determine the cost of the material, multiply the cost per board foot times the number of board feet.

10 2/3 board feet × \$0.45 board foot price = \$4.80 total cost for material.

PA Core Standard: CC.2.1.HS. F.1

Description: Apply and extend the properties of exponents to solve problems with rational exponents.

Math Associated Vocabulary:

SIMPLIFY NUMERICAL EXPRESSION, TERM

Formulas and Procedures:

P Do all operations in **PARENTHESIS**. Start with the innermost set.

E Evaluate all **EXPONENTS**.

M Do **MULTIPLICATION** and **DIVISION** in order from left to right.

D

A Do **ADDITION** and **SUBTRACTION** in order from left to right.

S

One way to remember the order of operations is:

Please Excuse My Dear Aunt Sally.

Remembering that my and dear go together since they both describe Aunt Sally who is one person.

Example:

$$\begin{aligned} (7 + 3)^2 - 21 \div 7 + 10(2) &= \\ 10^2 - 21 \div 7 + 10(2) &\text{P}arabtheses \\ 100 - 21 \div 7 + 10(2) &\text{E}xponents \\ 100 - 3 + 20 &\text{M}ultiplication and \text{D}ivision \\ 97 + 20 &\text{A}ddition and \text{S}ubtraction \\ = 117 & \end{aligned}$$

Instructor's Script - Comparing and Contrasting

Any field that uses formulas must also apply the order of operations to evaluate these formulas. The formula provided on the carpentry side of the T-Chart on page one uses only multiplication and division. In this case, following the order of operations will not affect the answer since multiplication and division are commutative (the order doesn't matter). For instance if you multiply 2×2 and then divide by 4, you'll get 1 as your answer. If you switch the order around and divide 2 by 4 and then multiply by 2, you'll still get 1 as your answer. Carpenters use other formulas that depend on the order of operations more extensively, like the Pythagorean theorem.

Students may wonder why the formula multiplies the thickness, width, and length and divides that product by 12. Thickness and width are measured in inches while length is measured in feet. If all of the dimensions were in inches the product would be divided by 144, since one board foot is equal to 144 cubic inches. Since one dimension is in feet, it must be converted to inches before the division takes place. This means it must be multiplied by 12 and then divided by 144. This can be simplified as $\frac{12}{144} = \frac{1}{12}$, therefore the product can be divided by 12 to obtain board feet.

Common Mistakes Made By Students

Improper use of calculators: Students are usually very quick to use calculators when faced with formulas but if they are not proficient in using the order of operations, they will not insert parentheses where needed or press “=” at the wrong points and arrive at incorrect answers.

Familiarity with the calculator: In some calculators, you must enter the radical sign first and in some calculators the radical sign is entered after the number is entered. Some calculators automatically do some of the correct order of operations. You need to know your calculator. Calculators are great tools, but you need to know the correct way to use them.

When entering the square of a negative number in a calculator it is important to put it in parentheses. You need to enter $(-2)^2$ not -2^2 . For the latter the calculator thinks you are saying the negative of 2 squared or -4, and not $(-2)(-2) = 4$.

When dealing with fractions students often will forget to put the numerator of the fraction and the denominator of the fraction in parentheses. If you enter $(3 + 6)/9$ into the scientific calculator, it recognizes that $3 + 6$ is in the numerator and does this operation first, giving the answer $9/9$ or 1. If you put $3 + 6/9$ (without the parentheses) into a scientific calculator, it will give you an answer of 3.66...

CTE Instructor's Extended Discussion

Carpenters needed to learn how to figure out board feet because that was the only way to purchase lumber, but today lumber yards sell material in linear feet or number of pieces needed. It is important for carpenters to learn and understand how to order and estimate the needed material for a job. By learning order of operations most carpenters will be successful in ordering the correct amount of material for their carpentry project.

Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. A carpenter purchased $35 - 2 \times 4 \times 8$, $15 - 2 \times 4 \times 12$ and $16 - 2 \times 4 \times 16$. How many linear feet of lumber did he purchase? LF = (#of pieces)(length)		
2. How many board feet are in $5 - 2'' \times 12'' \times 16'$?		
3. A painter needs to paint 4 walls and 1 ceiling in a dining room. The dining room measures 12' long, 10' wide and 9' high. What is the total surface area of the walls and ceiling?		
Problems	Related, Generic Math Concepts	Solutions
4. Simplify: $3(5 + 7)^2 - 10/5$		
5. Simplify: $5(8 + 2) + (-5 + (2 + 3)(7 - 4))$		
6. Simplify $(5 + 8)^2 - (7 + 5)^2$		
Problems	PA Core Math Look	Solutions
7. Simplify $(5 + 7 + 3) \div (3 + 2)$		
8. Simplify $5 + 7 + 3 \div 3 + 2$		
9. Compare problem #7 with problem #8. Explain how someone may make the mistake of thinking they are the same problem.		

Problems	Career and Technical Math Concepts	Solutions
1. A carpenter purchased $35 - 2 \times 4 \times 8$, $15 - 2 \times 4 \times 12$ and $16 - 2 \times 4 \times 16$. How many linear feet of lumber did he purchase?		$LF = (35)(8) + (15)(12) + (16)(16)$ $LF = 280 + 180 + 256$ $LF = 716$
2. How many board feet are in $5 - 2'' \times 12'' \times 16''$?		$\frac{2 \times 12 \times 16}{12} = \frac{384}{12} = 32$ board feet $32 \times 5 = 160$ total board feet
3. A painter needs to paint 4 walls and 1 ceiling in a dining room. The dining room measures 12' long, 10' wide and 9' high. What is the total surface area of the walls and ceiling?		$SA = 2(L)(H) + 2(W)(H) + 1(L)(W)$ $SA = 2(12)(9) + 2(10)(9) + 1(12)(10)$ $SA = 216 + 180 + 120 = 516 \text{ ft.}^2$
Problems	Related, Generic Math Concepts	Solutions
4. Simplify: $3(5 + 7)^2 - 10/5$		$3(5 + 7)^2 - 10/5 = 3(12)^2 - 10/5 = 3(144) - 10/5 = 432 - 2 = 430$
5. Simplify: $5(8 + 2) + (-5 + (2 + 3)(7 - 4))$		$5(8 + 2) + (-5 + (2 + 3)(7 - 4)) =$ $5(8 + 2) + (-5 + (5)(3)) =$ $5(10) + (-5 + 15) =$ $5(10) + (10) = 50 + 10 = 60$
6. Simplify $(5 + 8)^2 - (7 + 5)^2$		$(5 + 8)^2 - (7 + 5)^2 =$ $13^2 - 12^2 =$ $169 - 144 =$ 25
Problems	PA Core Math Look	Solutions
7. Simplify $(5 + 7 + 3) \div (3 + 2)$		Following the order of operations, $(5 + 7 + 3) \div (3 + 2) =$ Parenthesis $15 \div 5 =$ Division 3
8. Simplify $5 + 7 + 3 \div 3 + 2$		Following the order of operations, $5 + 7 + (3 \div 3) + 2 =$ Division $5 + 7 + 1 + 2 =$ Addition 15
9. Compare problem #7 with problem #8. Explain how someone may make the mistake of thinking they are the same problem.		In problem #7 you are asked to add $5 + 7 + 3$ first, then add $3 + 2$, and finally divide the two answers $(5 + 7 + 3)/(3 + 2)$. In problem #8, the first thing to do is divide 3 by 3 and then add $5 + 7 + 1 + 2$.