Cost Calculations Lesson Plan

Concept/principle to be demonstrated:

In construction and many other industries, it is common to convert various units of measure to a common unit. Calculating how much building supplies will cost ensures materials are not wasted and material purchases are kept within budget; in life and at work, calculating costs is essential to good budgeting. Understanding is demonstrated by accurately calculating and converting information in a variety of construction-related problems.

Lesson objectives/Evidence of Learning:

- Calculate the cost of lumber based on price per board foot, and linear foot price.
- Convert between price per linear foot, price per board foot and price per piece.
- Solve equations and equalities numerically, graphically, and algebraically
- Find the sum, difference, or product of two polynomials, then simplify the result
- Evaluate potential solutions for appropriateness, accuracy, and suitability to the context of the original problem.
- Create explanations that are appropriate to the needs of the audience and situation.
- Recognize and justify the need for an exact answer in a given situation.

How this math connects to construction jobs:

In construction, how lumber is priced varies. For instance, suppliers may provide quotes for lumber by the linear foot, by the board foot, or by the piece. It is important to know which unit is used to determine the material price. This "smart shopping" method is important in many industries that are dependent on manufactured goods; it is also important to making smart choices in personal budgets. This lesson will help students learn how to convert between these three methods is done in construction.

- **Wholesale suppliers** typically sell framing lumber by the thousand board foot.
- **Retailers** may provide linear foot pricing.
- **Carpenters** compute the number of pieces needed to complete a project.
- **Estimators** use quotes from many sources and must compare the same units.

Teacher used training aids:

- Several boards each equal to a board foot:
    - a) 1"x 12" x 12" long
    - b) 2" x 6" x 12" long
    - c) 1" x 6" x 24" long
    - d) 4" x 6" x 6" long
- Cans holding different volumes of the same product (i.e. 15 oz & 8 oz tomato sauce)

Materials needed per student:

- Calculator with √ key & memory +/- functions
- *Cost Calculation Worksheet*

Terms:

- **Board Foot (BF):** volume equal to 1" x 12" x 12" = 144 inches^3
- **MBF:** thousand (Roman numeral) board feet
- **Volume:** Thickness X Width X Length (T x W x L)

Lesson Introduction:

Framing lumber is bought and sold three ways: by the piece; by the linear foot; or by the board foot. Linear pricing is simply the length of the material without regard to the width and thickness; therefore, the linear measurement of an 8'-0" 2 x 12 is 8'-0". Likewise, the linear measurement of an 8'-0" 2 x 6 is also 8'-0". At the retail level (such as large home improvement stores), framing lumber is typically sold by the piece, or by the linear foot.

A wholesale lumber company usually sells by the board foot. It is different from linear measurement because board footage is calculated using the board's volume. The below example shows a board that is 12 inches wide, 1 inch thick and 12 inches long.

1"

12"

12"
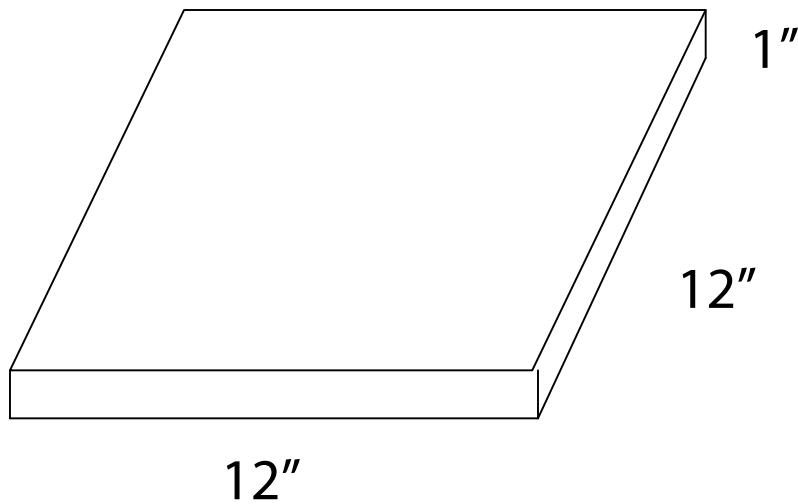
The volume of one board foot is calculated as: **12" x 12" x 1" = 144 inches^3**

Hand out board samples for students to examine (start with 1 x 12)
Explain:

Any piece of lumber equaling 144 cubic inches is one board foot. Framing lumber comes in many sizes. Each of these samples is equal to one Board Foot (BF).

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Lesson Components:

1. Board footage is the relationship or ratio between the volume of the board and the volume of a board foot. Compare the volume of a linear foot of 2 x 4:

    T = thickness in inches   **W** = width in inches   **L** = length in inches

    $$\frac{2 \text{ x } 4}{\text{Board foot}} \quad = \quad \frac{T" \text{ x } W" \text{ x } L"}{T" \text{ x } W" \text{ x } L"} \quad = \quad \frac{2" \text{ x } 4" \text{ x } 12"}{1" \text{ x } 12" \text{ x } 12"} \quad = \quad \frac{96 \text{ cubic inches}}{144 \text{ cubic inches}} \quad = \quad .667 \text{ BF}$$

2. To save a step of changing every length into inches, the formula can be shortened by expressing the length in feet:

    $\dfrac{T" \text{ x } W" \text{ x } L'}{1" \text{ x } 12" \text{ x } 1'}$ This formula can be further simplified by changing the denominator to 12". $\dfrac{T" \text{ x } W" \text{ x } L'}{\cancel{1"} \text{ x } 12" \text{ x} \cancel{1'}}$

    Simplified formula: $\dfrac{\textbf{T" x W" x L'}}{\textbf{12"}}$

    Write these practice exercises on the board:

    Calculate the board footage for one-foot lengths of the following:
2 x 6	2 x 6 x 1 ÷12= 1.0 BF (calculator key strokes given)
2 x 8	2 x 8 x 1 ÷12= 1.33BF
2 x 10	2 x 10 x 1 ÷12= 1.67BF
2 x 6	4 x 6 x 1 ÷12 = 2.0BF

    Now try with varying lengths. Replace the 1' length with the given length:
8'-0" length of 2 x 8	2 x 8 x 8 ÷12 = 10.67BF
12'-0" length 2 x 10	2 x 10 x 12 ÷ 12 = 20 BF
14'-0" length 2 x 6	2 x 6 x14 ÷ 12 = 14 BF
10'0" length 4 x 8	4 x 8 x 10 ÷ 12 = 26.67BF

3. Lumber quotes and field notes are frequently expressed in construction shorthand. The first number (12) indicates the number of pieces; the second number (8) is the length of material; the final figures (4 x 8) indicate the size of the lumber.

    12/8' 4 x 8 would be 12 pieces of 8' long 4 x 8's

    $\dfrac{\textbf{\# pcs. x T" x W" x L'}}{\textbf{12"}}$ Formula modified to include the number of pieces.

    How many total board feet are in these 12 pieces of lumber?

    $\dfrac{\cancel{12} \text{ x } 4 \text{ x } 8 \text{ x } 8}{\cancel{12}} = 256 \text{ BF}$ Note: the 12's cancel out.

    Write these practice exercises on the board:

    Calculating the board footage for of the following quantities:
16/10' 2 x 4	16 x 2 x 4 x 10 ÷12 = 106.67 BF
12/12' 4 x 4	12 x 4 x 4 x 12 ÷12= 192 BF
15/8' 2 x 8	15 x 2 x 8 x 8 ÷12=160 BF

4. Lumberyards deal in very large quantities of building materials. Their shipments arrive by the semi-truck or railroad car full. When giving quotes to customers, the quantity given is cost per thousand board feet. For example, 12 foot 2 x 4's might cost $575.00 per thousand board feet. It is written 575M. M is the Roman numeral for one thousand. To determine the cost per board foot, simply move the decimal point three places to the left. In this example, the cost per board foot is $0.575 or 57 _ ¢per board foot.

After determining the number of board feet, multiply the cost per board foot to get the total cost.

Write this example on the board: What is the cost of 1/12' 2 x 4 @ 575M?

$$\underline{\text{\# x T x W x L}} = \textbf{BF x \$ = Board Foot Cost}$$
$$12$$

$$\underline{\textbf{1 x 12 x 2 x 4}} = \textbf{8 x .575 = \$4.60}$$ A 12' 2x4 equals 8 BF and costs $4.60 each.
$$12$$

Write these practice exercises on the board:

Calculating the board footage and the price for of the following quantities:
10/12' 2 x 4 @ 480M   10 x 2 x 4 x 12 ÷12 = 80BF x $0.48 = $38.40
5/16' 4 x 6 @570M   5 x 4 x 6 x 16 ÷12 =160 BF x $0.57 = $ 91.20

5. Trim boards such as crown molding, casing and base trim are most often sold by the linear foot (LF). Pricing linear quantities is very easy. The lengths and number of pieces are added together and multiplied by the cost per foot.

Write this example on the board:

5/7' 1 x 6 @ $1.20 per LF   5 x 7 x $1.20 = $42.00

6. Have students work together to determine:

What's a better deal for 12' 2x4's?
(a) $360M, (b) $0.22 LF or (c) $2.56 each

Change all prices to the same unit for comparison. Using each price:
(a) $360M = 36¢ BF 12 x 2 x 4 ÷12 = 8 BF 36¢ x 8BF = $2.88 each
(b) 12' board costs 12 x 22¢= $2.64 each
(c) $2.56 each is best price!!!

7. Distribute *Cost Calculations Worksheet* and help students complete problems.

Cost Calculations Worksheet

Problem #1

Eight feet long 2 X 4's cost $2.64 each. What is the cost per board foot?

Problem #2

What is the price for the following lumber quantities?

        a. 120/8' 2 x 4 @ 480M   _____BF $_____

        b. 4/16' 4 x 6 @ 590M   _____BF $_____

        c. 29/10' 2 x 12 @ 610M   _____BF $_____

Problem #3

1 x 8's are quoted at $0.62 per linear foot. What is the price per board foot?

Problem #4

One supplier quoted select 1 x 6 pine at $955M. Another quoted $0.65 per linear foot. Which one is less expensive; how much less?

Cost Calculations Worksheet

Problem #1

Eight feet long 2 X 4's cost $2.64 each. What is the cost per board foot?

$$2 \times 4 \times 8 \div 12 = 5.33 \text{ BF} \qquad \$2.64 \div 5.33 = \$0.495 \text{ BF}$$

Problem #2

What is the price for the following lumber quantities?

a. 120/8' 2 x 4 @ 480M   **640 BF**   **$307.20**

b. 4/16' 4 x 6 @ 590M   **128 BF**   **$75.52**

c. 29/10' 2 x 12 @ 610M   **580 BF**   **$353.80**

Problem #3

1 x 8's are quoted at $0.62 per linear foot. What is the price per board foot?

$$1 \times 8 \div 12 = .67 \text{ BF} \qquad \$0.62 \div .67 = \$0.925$$

$$\$0.925 \times 1000 = \$925M$$

Problem #4

One supplier quoted select 1 x 6 pine at $955M. Another quoted $0.65 per linear foot. Which one is less expensive; how much less?

a. $955 ÷ 100 = .955 BF
b. 1 x 6 ÷ 12 = .5 BF   **$0.65 ÷ 0.5 = $1.30 BF**

$955M is less expensive by $0.345BF or 17.25¢/LF