TEXAS WORKFORCE COMMISSION

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MATHEMATICS for the CONSTRUCTION INDUSTRY

Student Workbook

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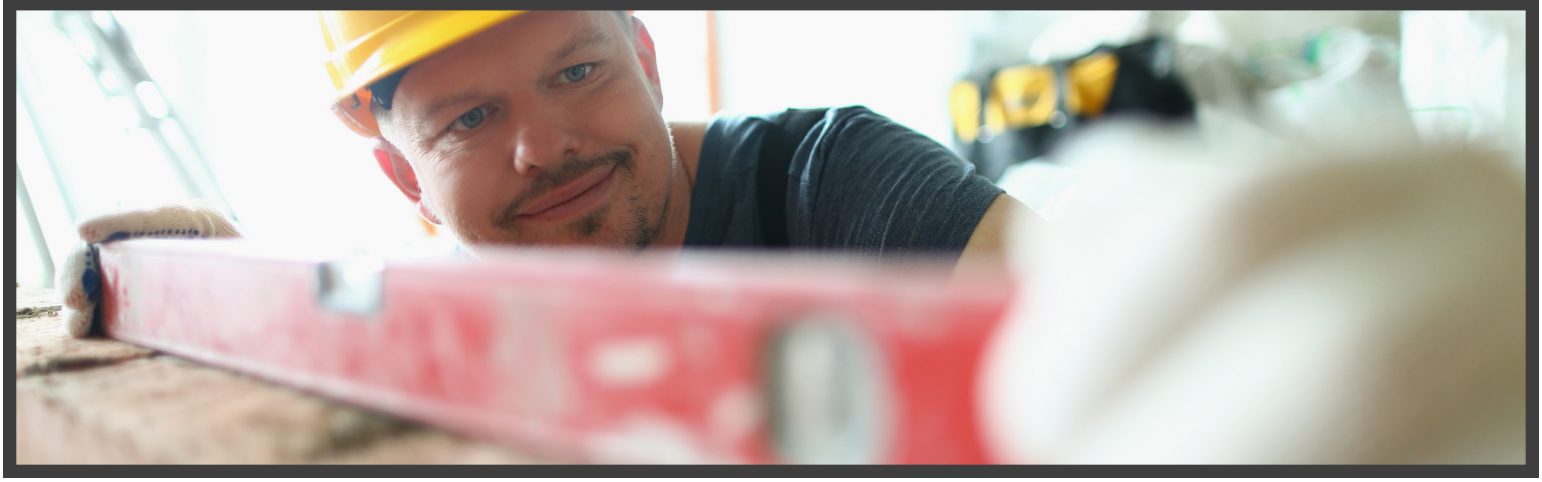


Introduction

There are many tools used in the construction industry. These include the basics, such as hammers, tape measures, and specialized tools for different types of work. Each tool requires understanding of the use and application to the work it is used for.

On a job site, you might see different tools with technology components, such as digital measuring devices. Before getting the job, you will need to have adequate math skills that allow you to evaluate, calculate, and communicate information.

This course will use hands-on activities to teach you the basic math skills needed for working in the construction field. You will focus on construction-related math skills, like working with fractions, decimals, and measurement conversions.

By the end of this course, you will be able to:

- **Perform basic math functions in construction**
- **Explain what math means in the workplace**
- **Apply mathematical thinking skills in the construction industry**

1. Everyday Math

In the construction industry, math is used for a variety of reasons. Whether your focus is general construction, plumbing, or electrical work, knowing the appropriate operations in basic math is an important part of working in construction. For example, your boss may ask you to complete estimated time logs or create an estimate for the cost of materials for a project.

The activities within this lesson will provide you with a basic understanding of multi-digit operations in math, building a foundation to be successful in your job now and in the future.

After completing this lesson, you will be able to:

1 - **Identify key terms in math operations**
2 - **Review relevant terms specific to plumbing, electrical, and general construction**
3 - **Demonstrate knowledge of multi-digit operations in math**
4 - **Solve real-world construction-related math problems**




Activity 1: Multi-Digit Addition & Subtraction

In the workplace, you may see various scenarios where you are required to add or subtract multi-digit numbers. For example, you may need to add together large quantities of materials, or you may need to find the perimeter of a workspace.

Practice your skills by completing the problems below.

Standard Algorithm for Addition:

$$\begin{array}{r} {\scriptstyle 1\ 1\ \ } \\ 537 \\ +\ 698 \\ \hline 1{,}235 \end{array}$$

Standard Algorithm for Subtraction:

$$\begin{array}{r} {\scriptstyle 4\ 12\ 12} \\ \cancel{5}\cancel{3}\cancel{2} \\ -\ 398 \\ \hline 134 \end{array}$$

Addition: Find the sum of the problems below.

1) $\begin{array}{r} {\scriptstyle 1\ 1\ \ } \\ 278 \\ +\ 153 \\ \hline 431 \end{array}$	2) $\begin{array}{r} 437 \\ +\ 248 \\ \hline \end{array}$	3) $\begin{array}{r} 179 \\ +\ 253 \\ \hline \end{array}$	4) $\begin{array}{r} 520 \\ +\ 286 \\ \hline \end{array}$
5) $\begin{array}{r} 379 \\ +\ 56 \\ \hline \end{array}$	6) $\begin{array}{r} 647 \\ +\ 206 \\ \hline \end{array}$	7) $\begin{array}{r} 716 \\ +\ 221 \\ \hline \end{array}$	8) $\begin{array}{r} 576 \\ +\ 328 \\ \hline \end{array}$

Subtraction: Find the difference of the problems below.

1) $\begin{array}{r} 463 \\ -\ 220 \\ \hline \end{array}$	2) $\begin{array}{r} 675 \\ -\ 322 \\ \hline \end{array}$	3) $\begin{array}{r} 968 \\ -\ 547 \\ \hline \end{array}$	4) $\begin{array}{r} 643 \\ -\ 523 \\ \hline \end{array}$
5) $\begin{array}{r} 879 \\ -\ 647 \\ \hline \end{array}$	6) $\begin{array}{r} 586 \\ -\ 421 \\ \hline \end{array}$	7) $\begin{array}{r} 688 \\ -\ 52 \\ \hline \end{array}$	8) $\begin{array}{r} 759 \\ -\ 417 \\ \hline \end{array}$

Activity 2: Multi-Digit Multiplication

Now that you have practiced addition and subtraction, use your skills to practice multi-digit multiplication.

Multi-digit multiplication is important when used with a variety of formulas in the plumbing, electrical, and general construction fields, which will be a focus in later lessons.

Standard Algorithm for Multiplication:

$$\begin{array}{r} 829 \\ \times\ 11 \\ \hline 829 \\ +\ 8{,}290 \\ \hline 9{,}119 \end{array}$$

Mulitiplication: Find the product of the problems below. Be sure to show your work.

1) 463 x 34	2) 647 x 12	3) 665 x 80	4) 545 x 73
5) 408 x 61	6) 258 x 33	7) 476 x 30	8) 836 x 57
9) 756 x 651	10) 141 x 352	11) 552 x 403	12) 561 x 230
13) 592 x 333	14) 110 x 291	15) 128 x 756	16) 924 x 435

Activity 2: Extra Workspace

Activity 3: Multi-Digit Division

In the workplace, multi-digit division is used to calculate loads and to scale models across the plumbing, electrical, and general construction fields.

Practice your skills to ensure that you are prepared for more advanced scenarios in later lessons.

Standard Algorithm for Division:

$$
\begin{array}{r}
176 \\
3\overline{)528} \\
-\ 3\downarrow \\
\hline
22 \\
-\ 21\downarrow \\
\hline
018 \\
-\ 18 \\
\hline
0
\end{array}
$$

Division: Find the quotient of the problems below. Use the space provided to show your work.

1) $12\overline{)816}$	2) $68\overline{)1020}$	3) $12\overline{)564}$	4) $29\overline{)1334}$
5) $51\overline{)1632}$	6) $69\overline{)3450}$	7) $19\overline{)323}$	8) $81\overline{)5184}$
9) $23\overline{)2047}$	10) $28\overline{)1708}$	11) $42\overline{)2688}$	12) $75\overline{)6750}$
13) $14\overline{)1036}$	14) $88\overline{)1584}$	15) $75\overline{)7275}$	16) $39\overline{)3159}$

Activity 3: Extra Workspace

Vocabulary Word Clues

There are a variety of word clues used to help identify whether to add, subtract, multiply, or divide.

Addition (+)
In All
Increased by
More than
Combined
Altogether
Total
Sum
Plus
Added to
Greater than

Subtraction (-)
Minus
Decreased By
Less
Take away
Difference
Less than
Fewer than
Left or Left over
Smaller than
Remaining

Multiplication (x)
Times
Multiplied by
Product of
Twice as much, (Three) times as much
In each
Every
Groups of
Rows of
By
At

Division (/)
Per
Out of
Ratio of
Quotient of
Percent
Equal (pieces, amount)
Split
Average
Share
Fraction of

Assessment: Math in the Workplace

Most math in the workplace will come in the form of written or verbal problems. Test your understanding by answering the questions below.

1. A plumber has the following lengths of PVC pipe: 3 feet, 9 feet, 8 feet, 13 feet, and 11 feet. What is the total length of PVC pipe?

2. A PVC pipe that is 242 feet long is to be cut into 2 foot pieces. How many pieces can a plumber get out of this length pipe?

3. If 4 electricians can complete a job in 8 hours, how long will it take 3 electricians to complete the same job?

Assessment: Math in the Workplace

4. An electrician needs 2 rolls of electrical wire to wire each room in a house. How many rooms can the electrician wire with 39 rolls of wire?

5. What is the square footage of a room 26’ x 52’?

6. It takes about 70 minutes to install a bathroom sink. You have already worked for 25 minutes. How many more minutes before you complete the job?

7. Luke has 220 feet of ½” pipe. He has used 105 feet of the pipe. How many feet does he have left?

Assessment: Math in the Workplace

8. You are building a house and worked 50 hours last week and 42 hours this week. How many more hours did you work last week?

9. You need a total of 662 bricks for your house project. You have 412 bricks. How many more bricks do you need?

10. A construction crew is replacing windows on two buildings. They will replace 32 windows on Monday, 41 windows on Tuesday, 38 windows on Wednesday, and 56 windows on Thursday. What is the total amount of windows that will be replaced throughout the week?

Check Your Understanding

In the construction industry, no matter what your job is, you might need to use math. Reflect on the importance of math in your field by answering the questions below.

Reflection

Do you feel comfortable with addition, subtraction, multiplication, and division? What do you feel like you need extra practice with?

What are two ways you use math in your current job?

Think of a future job you would like to have. Will you use math in the same way? If not, what will be different? What else do you need to learn?

2. Fractions and Decimals

Fractions and decimals appear everywhere in general construction, as well as in design-related plumbing and electrical problems. Whenever one quantity is broken down into a number of smaller quantities, the resulting smaller quantities represent fractions of the original. Measurements that cannot be expressed as whole numbers are commonly written in fraction or decimal form, for example, 2 and 3/4, or 2.75, which is between 2 and 3.

After completing this lesson, you will be able to:

1 - **Use models to understand benchmark fractions and decimals**
2 - **Convert fractions to decimals**
3 - **Convert decimals to fractions**
4 - **Use construction scenarios to calculate ratios, rates, and proportions**

Activity 1 Part A: Using Models

In this activity, you will use models to benchmark fractions and decimals. In the workplace, you may need to divide a whole number into fractional parts. Those parts have equivalent (equal) decimals. Practice your skills by filling in the chart below.

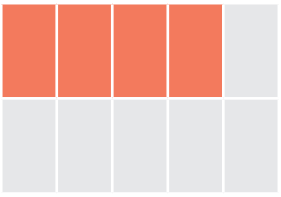
1.00 = 1/1						
.5						
.33333						
.25						
.2						
.167						
.142						

Activity 1 Part B: Using Models

To calculate equivalent (equal) fractions, simply multiply or divide the numerator and the denominator by the same number. See the examples below:

$$\frac{1}{2} \overset{\times 4}{=} \frac{4}{8}$$

$$\frac{4}{10} \overset{/ 2}{=} \frac{2}{5}$$



Practice by filling in the chart below:

1. $\frac{1}{3} = \frac{\square}{\square} \quad \frac{\square}{9}$

2. $\frac{2}{3} = \frac{\square}{\square} \quad \frac{\square}{6}$

3. $\frac{8}{12} = \frac{\square}{\square} \quad \frac{\square}{3}$

4. $\frac{4}{4} = \frac{\square}{\square} \quad \frac{\square}{2}$

5. $\frac{3}{5} = \frac{\square}{\square} \quad \frac{\square}{10}$

6. $\frac{6}{12} = \frac{\square}{\square} \quad \frac{\square}{2}$

7. $\frac{\square}{8} = \frac{\square}{\square} \quad \frac{2}{4}$

8. $\frac{5}{10} = \frac{\square}{\square} \quad \frac{\square}{2}$

Activity 2: Writing Fractions as Decimals

In the previous activity, you learned about equivalent fractions and decimals. Once you learn about those, it is important to know how to write fractions as decimals.

To convert a fraction to a decimal:

Fractions have numerators and denominators. Numerators are the top number of a fraction, and denominators are the bottom numbers. In the fraction to the right, **2** is the numerator and **6** is the denominator.

$$\frac{\textit{numerator}}{\textit{denominator}} \rightarrow \frac{2}{6}$$

Part of writing fractions is simplifying them by finding a common factor, the largest number the numerator and denominator can be divided by. In this case, the common factor is 2.
Here is how the fraction simplifies:

$$\frac{2}{6} \begin{matrix} /\,2 \\ /\,2 \end{matrix} \rightarrow \frac{1}{3}$$

Fractions can also demonstrate division problems. In this case, the numerator will be called the dividend, and the denominator will be called the divisor (since it is the value being divided). If we were to divide the fraction above, the answer would not be a whole number because 1 is smaller than 3. Instead, we would get its decimal form:

$$\frac{1}{3} = .333$$

Activity 2: Practice

Practice your skills by converting the fractions below to decimals.
Use the space provided to show your work.

1. $\frac{1}{5} =$

2. $\frac{3}{4} =$

3. $\frac{3}{8} =$

4. $\frac{4}{9} =$

5. $\frac{5}{8} =$

6. $\frac{7}{16} =$

7. $\frac{2}{10} =$

8. $\frac{11}{3} =$

Activity 2: Practice

Practice your skills by converting the fractions below to decimals.
Use the space provided to show your work.

(9) $\frac{7}{8}$ =	(10) $\frac{8}{15}$ =
(11) $\frac{8}{3}$ =	(12) $\frac{14}{20}$ =
(13) $\frac{7}{12}$ =	(14) $\frac{14}{10}$ =
(15) $\frac{7}{9}$ =	(16) $\frac{7}{11}$ =

Activity 3: Converting Decimals to Fractions

In the previous activity, you learned to use division to convert fractions to decimals. You might find that there are also instances where you have numbers presented in decimals that need to be converted to fractions.

To convert a decimal to a fraction:

Step 1: Write down the decimal divided by 1, like this: $\frac{\text{Decimal}}{1}$

Step 2: Multiply the numerator and the denominator by 10 for every number after the decimal point.

For example, if there are two numbers after the decimal point, then use 100, if there are three, then use 1000, etc.

Step 3: Simplify (or reduce) the fraction.

Example: Convert 0.75 to a fraction

Step 1: Write down the decimal (0.75) divided by 1:

$$\frac{0.75}{1}$$

Step 2: Multiply the numerator and the denominator by 100:

(since there are 2 digits after the decimal point, that is 10 x 10 =100)

$$\frac{0.75}{1} \begin{matrix}\text{x } 100 \\ = \\ \text{x } 100\end{matrix} \frac{75}{100}$$

Hint: Notice how it turns the numerator into a whole number.

Step 3: Simplify the fraction:

(in this case, it takes two steps)

$$\frac{75}{100} \begin{matrix}/ 5 \\ / 5\end{matrix} = \frac{15}{20} \begin{matrix}/ 5 \\ / 5\end{matrix} = \frac{3}{4}$$

Activity 3: Practice

Practice your skills by converting the decimals below to fractions.
Use the space provided to show your work.

1. **0.5 =**
2. **0.667 =**
3. **0.625 =**
4. **0.8 =**
5. **0.3 =**
6. **0.6 =**
7. **0.375 =**
8. **0.333 =**

Activity 3: Practice

Practice your skills by converting the decimals below to fractions.
Use the space provided to show your work.

9 **0.25 =**	10 **0.2 =**
11 **0.125 =**	12 **0.8125 =**
13 **0.5624 =**	14 **0.6875 =**
15 **0.15625 =**	16 **0.875 =**

Activity 4: Adding & Subtracting Decimals

Since using fractions and decimals is common in many work environments, the next step is learning how to add and subtract fractions and decimals. To add and subtract decimals, line up the decimals and add or subtract as you normally would. Review the instructions, then practice your skills.

Adding and Subtracting Decimals:

Example 1: Add 1.5 + 2.14

Step 1: Line up the decimal points.

```
  1.5
+ 2.14
```

Step 2: Insert zeros to have the same number of digits for both numbers.

```
  1.50
+ 2.14
```

Step 3: Add, starting with the hundreds place.

```
  1.50
+ 2.14
     4
```

Step 4: Continue with the tenths place.

```
  1.50
+ 2.14
    64
```

Step 5: Place the decimal point so that it lines up vertically.

```
  1.50
+ 2.14
   .64
```

Step 6: Add the ones place.

```
  1.50
+ 2.14
  3.64
```

Example 2: Subtract 4.67 - 2.15

Step 1: Line up the decimal points.

```
  4.67
- 2.15
```

Step 2: Subtract, starting with the hundreds place.

```
  4.67
- 2.15
     2
```

Step 3: Continue with the tenths place.

```
  4.67
- 2.15
    52
```

Step 4: Place the decimal point so that it lines up vertically.

```
  4.67
- 2.15
   .52
```

Step 5: Subtract the ones place.

```
  4.67
- 2.15
  2.52
```

Activity 4: Practice

Addition: Find the sum of the problems below.

1 **1 + 0.02 =** _____	2 **0.2 + 0.1 =** _____
3 **0.4 + 0.2 =** _____	4 **1 + 6 =** _____
5 **0.06 + 4 =** _____	6 **6 + 0.5 =** _____
7 **0.00 + 3 =** _____	8 **0.4 + 5 =** _____
9 **0.3 + 0.4 =** _____	10 **0.05 + 0.2 =** _____
11 **1 + 0.1 =** _____	12 **0.05 + 0.4 =** _____

Activity 4: Practice

Subtraction: Find the difference of the problems below.

1) 4 - 3.4 = _____	2) 7 - 0.051 = _____
3) 9 - 0.068 = _____	4) 10 - 0.084 = _____
5) 6 - 1.7 = _____	6) 60 - 5.3 = _____
7) 2 - 0.062 = _____	8) 7 - 0.086 = _____
9) 5 - 0.037 = _____	10) 50 - 0.94 = _____
11) 4 - 0.082 = _____	12) 40 - 0.97 = _____

Activity 5: Adding & Subtracting Fractions

Adding and subtracting fractions uses the same idea as adding and subtracting decimals: Ensure you have the same denominator, then add or subtract the numerators, keeping the denominator the same.

Adding and Subtracting Fractions:

Example 1: Adding

Jason has 2/8 of a pack of wire and Ernie has 4/8 of the same pack. How much of the pack do they have altogether?

$$\underset{\text{Jason}}{\frac{2}{8}} \qquad \underset{\text{Ernie}}{\frac{4}{8}}$$

Since the denominators are the same, we can just add the numerators.
(2 + 4 to get 6)

$$\underset{\text{Jason}}{\frac{2}{8}} + \underset{\text{Ernie}}{\frac{4}{8}} = \frac{6}{8}$$

Tip: Do not add the denominators by accident.

Jason and Ernie have **6/8** of the pack altogether.

$$\frac{6}{8}$$

Example 2: Subtracting

Jason has 9/6 of a pack of wire and Ernie used 4/6 of the pack. How much wire does Jason have left?

$$\underset{\text{Jason}}{\frac{9}{6}} \qquad \underset{\text{Ernie}}{\frac{4}{6}}$$

We have the same denominator, so we can subtract numerators.
(9 – 4 to get 5)

$$\underset{\text{Jason}}{\frac{9}{6}} - \underset{\text{Ernie}}{\frac{4}{6}} = \frac{5}{6}$$

Jason has **5/6** of the pack of wire left.

$$\frac{5}{6}$$

When the denominators aren't the same, find the least common denominator using the steps you learned earlier with equivalent fractions.

Activity 5: Adding & Subtracting Fractions

Adding and Subtracting Fractions:

Example 3: Finding a Common Demoninator, Comparing and Adding

Kenny painted 1/3 of a fence on Monday and 2/5 of the same fence on Tuesday. On which day did he paint more of the fence? How much of the fence did Kenny paint altogether?

$$\frac{1}{3} \quad \frac{2}{5}$$

Monday **Tuesday**

- This question is asking us to compare and then add two fractions.
- List out multiples of the denominators and look for the first one that's the same for both numbers. This is called the common denominator.

	x 1	x 2	x 3	x 4	x 5
3	3	6	9	12	15
5	5	10	15	20	25

- Then, convert each fraction to the shared common denominator.

$$\frac{1}{3} \begin{matrix} \times 5 \\ = \\ \times 5 \end{matrix} \frac{5}{15}$$

Monday

$$\frac{2}{5} \begin{matrix} \times 3 \\ = \\ \times 3 \end{matrix} \frac{6}{15}$$

Tuesday

Kenny painted 5/15 of the fence on Monday and 6/15 on Tuesday. To compare the fractions, we compare the numerators (5 and 6). 6 is larger, meaning Kenny painted more of the fence on Tuesday. Finally, we add the two fractions to see how much he painted on both days.

$$\frac{5}{15} + \frac{6}{15} = \frac{11}{15}$$

Monday **Tuesday**

Remember:
Do not add the denominators.

Activity 5: Practice

Addition: Find the sum of the fractions below.

1. $\frac{2}{9} + \frac{5}{3} =$

2. $\frac{2}{10} + \frac{5}{10} =$

3. $\frac{3}{5} + \frac{4}{1} =$

4. $\frac{6}{7} + \frac{1}{4} =$

5. $\frac{5}{2} + \frac{2}{5} =$

6. $\frac{5}{3} + \frac{1}{6} =$

Activity 5: Practice

Addition: Find the sum of the fractions below.

7. $\frac{1}{9} + \frac{6}{7} =$

8. $\frac{7}{11} + \frac{7}{4} =$

9. $\frac{2}{9} + \frac{11}{3} =$

10. $\frac{8}{3} + \frac{3}{4} =$

11. $\frac{1}{9} + \frac{3}{5} =$

12. $\frac{3}{10} + \frac{8}{2} =$

Activity 5: Practice

Subtraction: Find the difference of the fractions below.

1. $\frac{3}{4} - \frac{5}{12} =$

2. $\frac{13}{15} - \frac{8}{15} =$

3. $\frac{4}{5} - \frac{7}{20} =$

4. $\frac{2}{3} - \frac{1}{9} =$

5. $\frac{9}{16} - \frac{1}{4} =$

6. $\frac{17}{21} - \frac{11}{21} =$

Activity 5: Practice

Subtraction: Find the difference of the fractions below.

7. $\frac{13}{21} - \frac{2}{7} =$

8. $\frac{6}{7} - \frac{5}{14} =$

9. $\frac{17}{18} - \frac{5}{6} =$

10. $\frac{2}{3} - \frac{2}{15} =$

11. $\frac{7}{9} - \frac{6}{27} =$

12. $\frac{5}{8} - \frac{7}{32} =$

Activity 5: Extra Workspace

Activity 6: Ratios, Rates, & Proportions

Once you have mastered fractions, you can move into calculating ratios, rates, and proportions. A ratio is a comparison of 2 quantities using division, for example, 2 nails to 1 board. You can write it in the following ways: 2/1, 2 to 1, or 2:1. Like fractions, ratios can be reduced.

Understanding the difference in each term:

- **A rate** is simply a ratio that compares quantities measured in different units: **5 ft per 30 sec** OR $\frac{\text{5 feet}}{\text{30 seconds}}$
- **A unit rate** is a rate whose denominator is 1: **55 mph** OR $\frac{\text{55 miles}}{\text{1 hour}}$
- **A proportion** is an equation that shows 2 ratios are equal: $\frac{3}{5} = \frac{9}{15}$

Practice: Ratios

1. If your company won 70 bids and lost 40 bids, which of the following ratios is representative of this fact?

◯ a. 7:2 ◯ b. 7:4 ◯ c. 7:5 ◯ d. 7:6

2. In your small business, 40 of the employees are men and 30 of the employees are women. What is the ratio of women to men?

3. The length of a concrete pad is 20 feet and the width is 15 feet. What is the ratio of length to width?

4. The recommended mixing ratio for mortar is 3 parts of sand to 1 part of cement for each gallon. What is the ratio of sand to cement for 5 gallons?

Activity 6: Ratios, Rates, & Proportions

Practice: Rates and Unit Rates

1. A forklift can go 400 miles on 8 gallons of gas. How far can the forklift go with 1 gallon of gas?

2. Your project uses 330 linear feet of PVC pipe for the 5-day work week. How much PVC pipe do you need per day?

3. You are wiring a building for electricity and need 210 feet of wire to run the wire throughout the 7-room building. Approximately how many feet of wire is being used in each room?

4. You purchased 212 sinks for a new apartment building project. Your total bill was $30,952. What is your cost per sink?

5. Your company spends $455 to produce 50 switches. What is the cost per switch?

Activity 6: Practice

Practice: Proportions

1. If 2 cubic feet of water is 15 gallons, then how many gallons is 3.5 cubic feet of water?

2. An 8 foot 2 x 4 weighs 9 lbs. on average, then how much does a 12 foot 2 x 4 weigh?

3. If the pitch of a pipe with a run of 96 feet is a 1 foot drop, how many feet is the drop for a 384 foot run?

4. A Journeyman and an apprentice complete 200 five-inch joints in 8 hours. How many five-inch joints do they complete in 24 hours?

5. A 4-man job costs $1,200 per day in labor. How much would a 6-man job cost per day in labor?

Check Your Understanding

Reflect on the importance of fractions and decimals by answering the questions below.

Reflection

Do you remember how to convert between a fraction and a decimal? When might you need to do this in your workplace?

Describe a relationship between two quantities (a ratio) you might see in your industry.

Write a rate to represent a situation in your workplace or field. What does that rate mean?

3. Measurement

Accurate measurements are important in any area of the construction field. For example, a carpenter needs to use a tape measure to measure, mark, and cut wood. A plumber needs to understand the different sizes of fittings and fixtures and measure the correct length of a pipe. This unit will prepare you to understand various measurement concepts and tools used in construction.

After completing this lesson, you will be able to:

1 - **Identify measurement tools used in the plumbing, electrical, and general construction fields**
2 - **Convert units with a metric system**
3 - **Calculate squares, cubes, and square root**
4 - **Calculate perimeter, area, and volume**

Activity 1: Basic Measurement

The first step in measurement is to be familiar with the different types of measurement tools used in your field. In this activity, review the measurement tools used in plumbing, electrical, and general construction.

Straight Edge
A straight edge differs from a ruler because it has no marking for measurement. Instead, a straight edge is a long wooden or metallic instrument with a perfectly flat edge, used to check the straightness of lines or to maintain an undeviating linear path. Straight edges can come in different materials, sizes, weights and lengths.

Steel Rule
Also known as a ruler, this steel rule is a measuring tool that helps make accurate measurements using predefined markings, like inches and centimeters. A steel rule can be rigid or flexible and can be used as a guide for laying out lines. A very rigid steel rule could even be used as a guide for cutting.

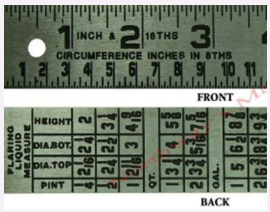
Scriber
A scriber is a tool used when measuring metal to mark lines to show where to cut. It is made of a rod with a tip of cast steel that has been hardened and sharpened to a point. It leaves a mark by dragging the point over the metal to create a shallow scratch. A scriber is used instead of a pen or pencil because regular ink lines are hard to see and too easily erased.

Scribing Compass & Divider
These terms are often interchanged, but technically, a divider has two sharp points, and a compass has one pencil or pen point and one sharp point. Both tools help accurately mark and measure and draw circles and arcs.

Activity 1: Basic Measurement

Trammel
A trammel is a tool used to draw circles and arcs that are larger than can be drawn with a divider or compass. They can also be used to bisect lines and angles.

Circumference Rule
Also known as a tinner's rule, the circumference rule has a regular measuring scale on the top edge like a steel rule, with the added functionality of circumference measurements on the bottom edge.



Try Square
A try square is a tool used for measuring and marking a square piece of material. The square can be used to determine the accuracy of a 90-degree angle.

Multimeter
A multimeter is a tool used to measure three basic electrical characteristics (voltage, current, and resistance).

Oscilloscope
An oscilloscope is a tool used to measure the voltage level of an electronic circuit.

Clamp Meter
A clamp meter is a tool used to measure the electric current on a cable or any media.

Activity 1: Basic Measurement

ESR Meter
An ESR meter is a tool used to measure the internal resistance level of a capacitor in an electronic circuit.

Wattmeter
A wattmeter is a tool used to measure the electric power of a circuit or electronic device.

Tape Measure
A tape measure is used to find exact measurements.

Measuring Wheel
A measuring wheel is used to measure a lot, a plot of land, or a foundation. Measuring wheels move with you as you walk.

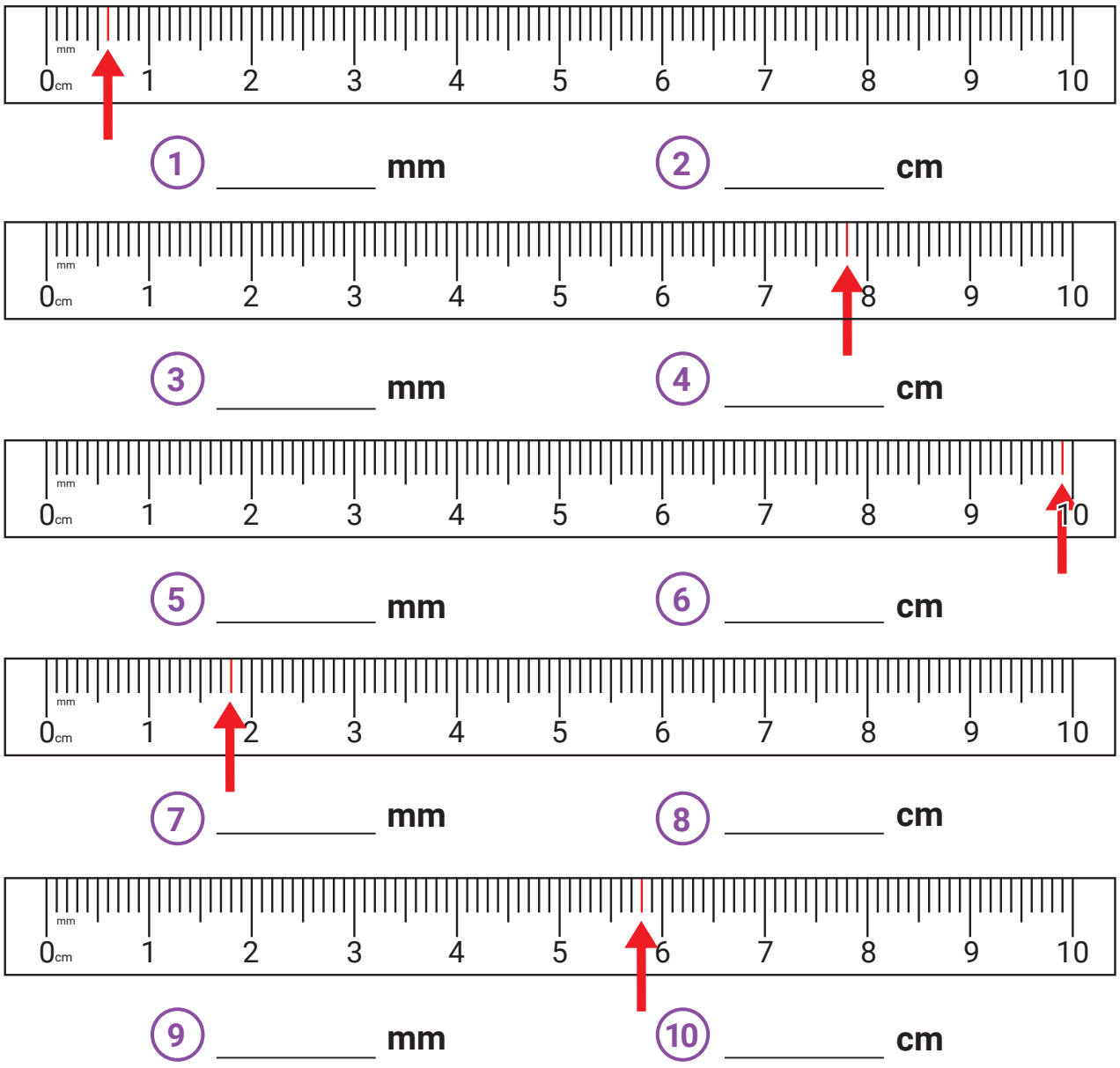
Diameter Tape
A diameter tape measure is used to measure around objects like pipes, trees, and other round objects.

Level
A level is used to measure and determine at a glance if something is level with .5 mm/m, .0005 in/in, and .029.

Activity 2: Measurement

Although many different tools are used to measure across industries, the basic goal is the same: to obtain accurate measurements. Whether your industry uses standard or metric measurements, it is important to be accurate because measurements can impact safety, stability, and cost. Using your previous knowledge of fractions and decimals, practice recording accurate measurements below.

Record the length measurement at the point marked by the arrow in both millimeters and centimeters.



Activity 3: Converting Measurements

Now that you have familiarized yourself with reading measurements, it is time to practice converting measurements. Many times once measurements are taken, you are required to convert the measurement into a different unit (either standard or metric).

Mass & Weight
1 ton = 2,000 pounds
1 pound = 16 ounces

Length
1 mile = 5,280 feet
1 yard = 3 feet
1 foot = 12 inches

Capacity
1 gallon = 4 quarts
1 quart = 2 pints
1 pint = 2 cups
1 cup = 8 fluid ounces

Time
1 year = 365 days
1 year = 52 weeks
1 hour = 60 minutes
1 minute = 60 seconds

Use the tables provided to convert each unit of measurement.

1. **2 yards =** _____ feet
2. **18 inches =** _____ feet
3. **0.5 miles =** _____ feet
4. **310 yards =** _____ inches
5. **5 gallons =** _____ quarts
6. **2 gallons =** _____ pints
7. **18 cups =** _____ pints
8. **4 quarts =** _____ pints
9. **6 cups =** _____ fluid oz
10. **32 fluid oz =** _____ cups
11. **1 ton =** _____ ounces
12. **192 ounces =** _____ pounds
13. **3 pounds =** _____ ounces
14. **2.5 tons =** _____ pounds
15. **14 weeks =** _____ days
16. **19 minutes =** _____ seconds

Convert each customary unit of measurement.

17. **3 cups + 2 fluid ounces =** _____ fluid ounces
18. **2 feet + 3 inches =** _____ inches
19. **4 feet + 3 inches =** _____ inches
20. **75 inches =** _____ feet **+** _____ inches

Activity 4: Comparing Measurements

When reading measurements in different units, it is important to understand how the units compare. Use the table below to practice comparing each measurement as either less than (<), greater than (>), or equal to (=).

Mass & Weight
1 ton = 2,000 pounds
1 pound = 16 ounces

Length
1 mile = 5,280 feet
1 yard = 3 feet
1 foot = 12 inches

Capacity
1 gallon = 4 quarts
1 quart = 2 pints
1 pint = 2 cups
1 cup = 8 fluid ounces

Time
1 year = 365 days
1 year = 52 weeks
1 hour = 60 minutes
1 minute = 60 seconds

1. 30 inch _____ 1 yard
2. 1 gallon _____ 8 pints
3. 4.5 pounds _____ 70 ounces
4. 18 ounces _____ 3 pounds
5. 4 pints _____ 6 cups
6. 20 gallons _____ 40 quarts
7. 4 pounds _____ 40 ounces
8. 2.5 yards _____ 60 inches
9. 5 feet 2 inches _____ 65 inches
10. 2 cups _____ 1 quarts
11. 16 cups _____ 4 pints
12. 5 pounds _____ 80 quarts

Compare each set of customary measurements using <,>, or =:

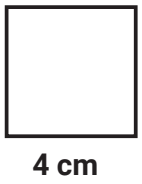
13. 8 quarts + 1 pint _____ 32 cups
14. 68 pints _____ 8 gallons + 2 quarts
15. 48 feet _____ 1 yard + 9 inches
16. 2 pints + 8 ounces _____ 5 cups
17. 72 inches _____ 5 yards + 10 inches
18. 10 cups + 16 ounces _____ 5 pints + 1 cup

Activity 5: Perimeter

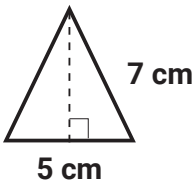
Perimeter measures the outside boundary of a two-dimensional shape. There are many instances where you may need to measure around an object or figure. Sometimes those objects and figures may be irregularly shaped. Practice the exercises below. Be sure to apply the appropriate formula to the shape. Remember, the perimeter is simply adding the outside edge of a two-dimensional shape, so the formulas are just shortcuts to adding all the sides.

Shape	Perimeter Formula	Terms
Parallelogram	2(Base + Height)	-
Triangle	a + b + c	a, b, and c being the side lengths
Rectangle	2(Length + Width)	-
Square	4a	a = Length of a side
Hexagon	6a	a = Length of a side

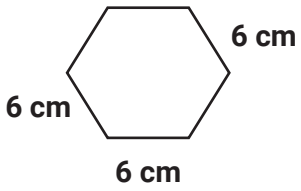
Solve: Find the perimeter for each shape below.

1. 

Perimeter = _____

2. 

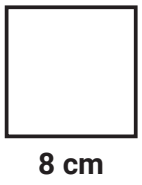
Perimeter = _____

3. 

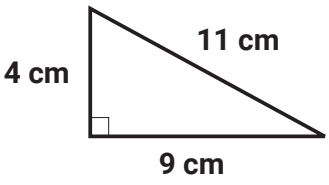
Perimeter = _____

4. 

Perimeter = _____

5. 

Perimeter = _____

6. 

Perimeter = _____

Activity 6: Area

Perimeter and area are very different but often get confused. Perimeter is described as the outside edge of a shape while area is the "stuff inside" the shape. In general, the area of shapes can be defined as the amount of paint required to cover the surface with a single coat. Calculating the area of each shape has its own unique formula.

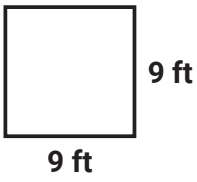
Shape	Area Formula	Terms
Circle	πr^2	π = 3.14, r = Radius of the circle
Triangle	1/2(bh)	b = Base, h = Height
Square	a^2	a = Length of side
Rectangle	lw	l = Length, w = Width
Parallelogram	6a	a = Length of side
Trapezium	1/2(a+b) x h	a and b = Length of parallel sides h = Height

Solve: Find the area for each shape below.

1

Area = _____

2

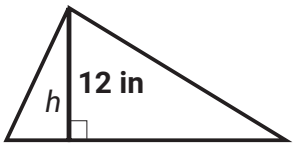


Area = _____

3

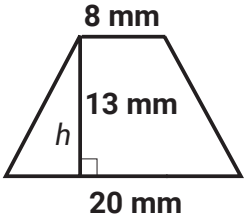
Area = _____

4



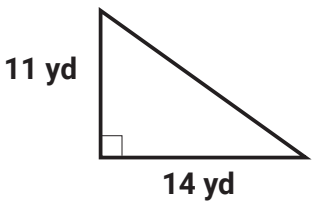
Area = _____

5



Area = _____

6

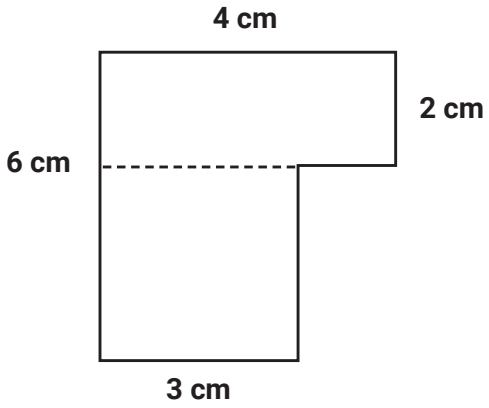


Area = _____

Activity 6: Practice

Solve: Practice calculating the area AND the perimeter for the shapes below.

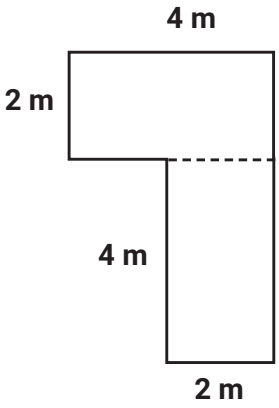
1



Perimeter = _____

Area = _____

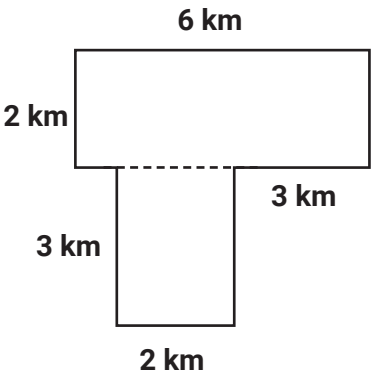
2



Perimeter = _____

Area = _____

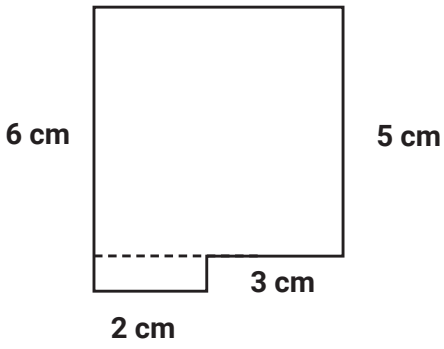
3



Perimeter = _____

Area = _____

4



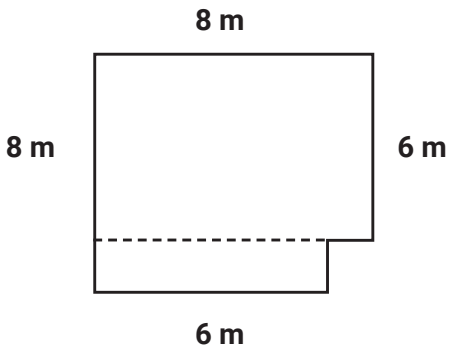
Perimeter = _____

Area = _____

Activity 6: Practice

Solve: Practice calculating the area AND the perimeter for the shapes below.

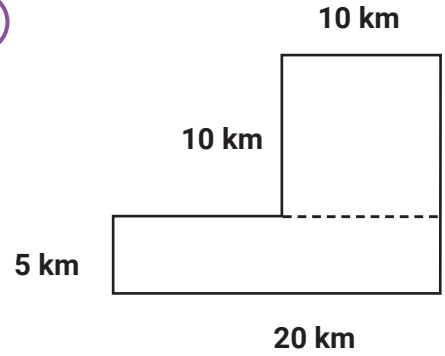
5



Perimeter = _____

Area = _____

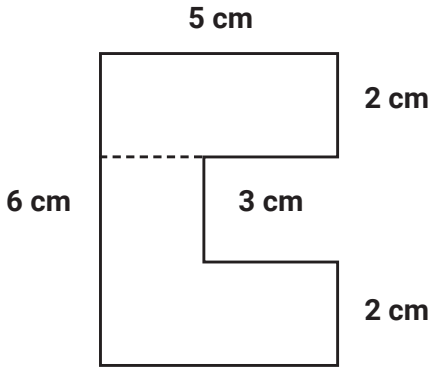
6



Perimeter = _____

Area = _____

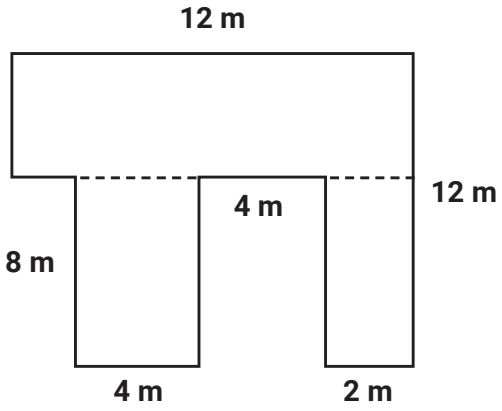
7



Perimeter = _____

Area = _____

8



Perimeter = _____

Area = _____

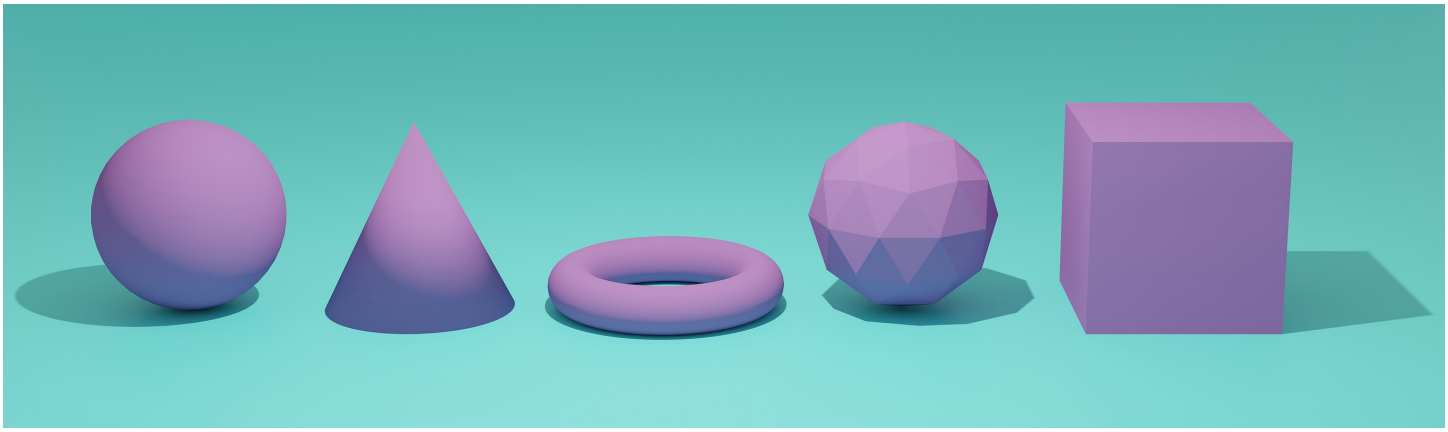
Activity 6: Extra Workspace

Activity 7: Volume

Volume is defined as a capacity occupied by a three-dimensional solid shape. In any shape, it is hard to visualize but can be compared between shapes. For example, the volume of a toolbox is greater than the volume of a tape measure placed inside it. As we learned in the last lesson, for calculating the area of any two-dimensional shape, we divide the portion into equal square units. Similarly, while calculating the volume of solid shapes we will divide it into equal cubical units.

Every object in our surroundings has a nature of occupying space. These real-life objects can be easily compared with the basic 3-D shapes. Like perimeter and area, calculating the volume of each shape has its own unique formula. Using the formulas below, practice calculating the volume of each shape.

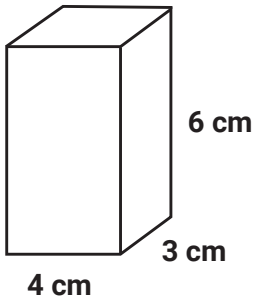
Shape	Volume Formula	Terms
Cube	a^3	a = Length of a side
Cuboid	lbh	l = Length, b = Base, h = Height
Cone	$(1/3)\pi r^2 h$	π = 3.14, r = Radius, h = Height
Cylinder	$\pi r^2 h$	π = 3.14, r = Radius, h = Height
Sphere	$(4/3)\pi r^3$	π = 3.14, r = Radius
Hemisphere	$(2/3)\pi r^3$	π = 3.14, r = Radius
Prism	bh	b = Base, h = Height
Pyramid	(1/3)bh	b = Base, h = Height



Activity 7: Practice

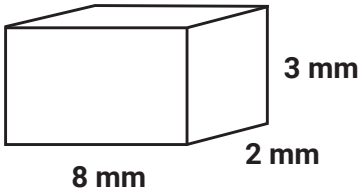
Solve: Practice calculating the volume for the shapes below.

1



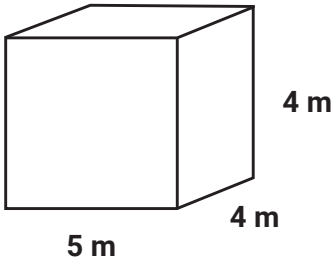
Volume = _____

2



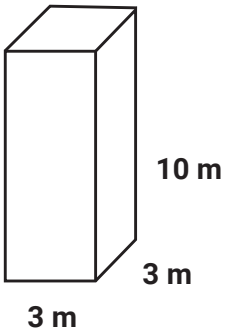
Volume = _____

3



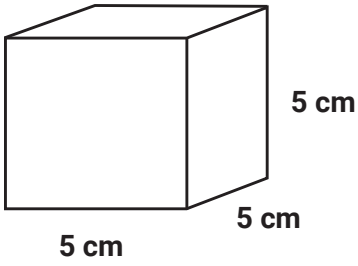
Volume = _____

4



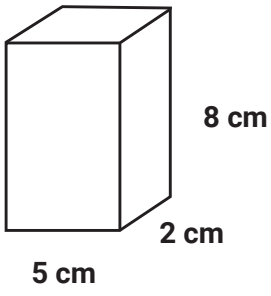
Volume = _____

5



Volume = _____

6

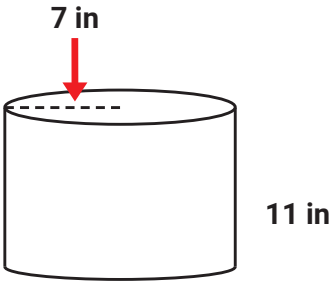


Volume = _____

Activity 7: Practice

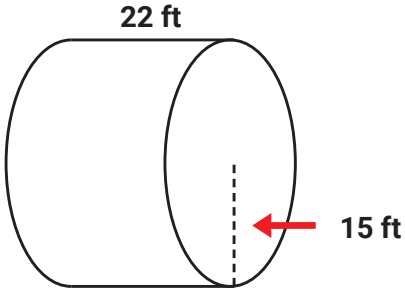
Solve: Practice calculating the volume for the shapes below.

7



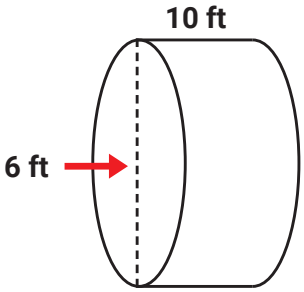
Volume = _____

8



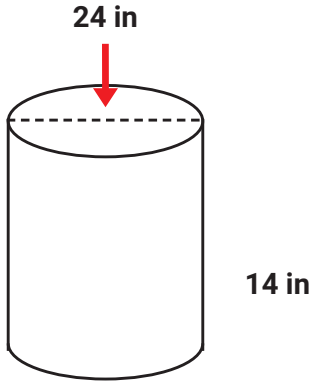
Volume = _____

9



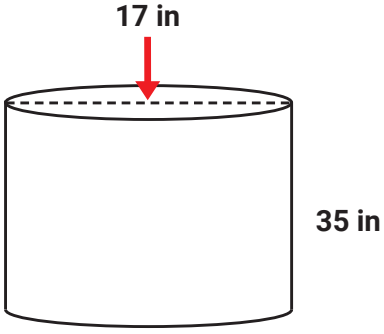
Volume = _____

10



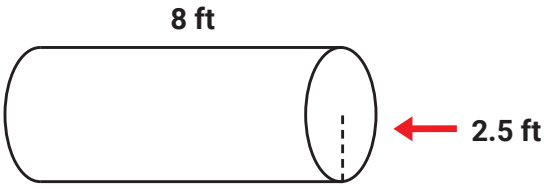
Volume = _____

11



Volume = _____

12



Volume = _____

Vocabulary

Some of the vocabulary words you learned in this lesson are listed below.
Refer back to this page if you need help remembering.

Vocab Word	Definition
Amperes	The basic unit of electrical current in the International System of Units (SI).
Analog	Displaying a readout by a pointer or hands on a dial rather than by numerical digits.
Angle	The space within two lines or three or more planes diverging from a common point, or within two planes diverging from a common line.
Area	The quantitative measure of a plane or curved surface; two-dimensional extent.
Capacity	The maximum amount or number that can be received or contained; cubic contents; volume.
Celsius	Pertaining to or noting a temperature scale (Celsius scale) in which 0° represents the ice point and 100° represents the steam point.
Circumference	The outer boundary, especially of a circular area; perimeter.
Deep/Depth	A dimension taken through an object or body of material, usually downward from an upper surface, horizontally inward from an outer surface, or from top to bottom of something regarded as one of several layers.
Diagonal	Connecting two nonadjacent angles or vertices of a polygon or polyhedron, as a straight line.
Diameter	A straight line passing through the center of a circle or sphere and meeting the circumference or surface at each end, the width of a circular or cylindrical object.
Digital	Displaying a readout in numerical digits rather than by a pointer or hands on a dial.
Fahrenheit	Noting, pertaining to, or measured according to a temperature scale (Fahrenheit scale) in which 32° represents the ice point and 212° represents the boiling point.

Vocabulary

Vocab Word	Definition
High/Height	The extent or distance upward; distance upward from a given level to a fixed point.
Horizontal	At right angles to the vertical; parallel to level ground.
Long/Length	The measure of the greatest dimension of a plane or solid figure.
Linear	Involving measurement in one dimension only; pertaining to length.
Load	A measure of the warmth or coldness of an object or substance with reference to some standard value.
Mass	A collection of incoherent particles, parts, or objects regarded as forming one body.
Metric	Pertaining to the meter or to the metric system.
Ohms	The standard unit of electrical resistance in the International System of Units (SI).
Parallel	Extending in the same direction, equidistant at all points, and never converging or diverging.
Perimeter	The border or outer boundary of a two-dimensional figure.
Pressure	The exertion of force upon a surface by an object, fluid, etc.
PSI	The abbreviation for pressure, (Pound per Square Inch).
Radius	A straight line extending from the center of a circle or sphere to the circumference or surface, radius is half the diameter.
Standard/English	Norms of spelling, grammar, and usage in written and spoken contexts, and neutralizing nonstandard dialectal variation.

Vocabulary

Vocab Word	Definition
Temperature	A straight line extending from the center of a circle or sphere to the circumference or surface, radius is half the diameter.
Thick/Thickness	Measured, as specified, between opposite surfaces, from top to bottom, or in a direction perpendicular to that of the length and breadth; (of a solid having three general dimensions) measured across its smallest dimension.
Units	Any specified amount of a quantity, as of length, volume, force, momentum, or time.
Vertical	Being in a position or direction perpendicular to the plane of the horizon; upright.
Volts	The standard unit of potential difference and electromotive force in the International System of Units (SI).
Volume	The amount of space, measured in cubic units, that an object or substance occupies.
Watts	The standard unit of power in the International System of Units (SI).
Weigh/Weight	A unit of heaviness or mass.
Wide/Width	The extent from side to side.

Check Your Understanding

Now that you have practiced measurement, perimeter, area, and volume, practice using those skills. First, download a measurement app on a mobile phone. Some examples are provided below.

Android Measuring and Conversion Apps:

US-Metric/Imperial Converter
MobiSys
4.9 ★

Ruler
NixGame
4.6 ★

Metric Conversions
metric-conversions.org
4.6 ★

Unit Converter
Digit Grove
4.5 ★

Ruler App: Camera Tape Measure
Grymala
3.9 ★

Ruler
Xalpha Lab
4.5 ★

Apple Measuring and Conversion Apps:

Measure 4+
Apple
3.4 • 746 Ratings
Free

Convert Any Unit Lite 4+
Units & Currency Converter
Cider Software LLC
4.7 • 43.2K Ratings
Free

Tape Measure™ 4+
Measure with your phone
Level Labs, LLC
#127 in Utilities
4.4 • 69.7K Ratings
Free · Offers In-App Purchases

Unit Converter Calculator Pro 4+
Simple With Metric & Imperial
Rome Rock LLC
Designed for iPad
4.7 • 599 Ratings
Free · Offers In-App Purchases

Check Your Understanding

Use the measurement app(s) you downloaded to complete the tasks below.

Apps in practice:

1. Measure 5 objects in your workspace. Be sure to measure all sides.
2. Calculate the perimeter of each object.
3. Calculate the area of each object.
4. Calculate the volume of each object.
5. Create a spreadsheet in Excel to record your results.

Object	Measurements	Perimeter	Area	Volume

Additional Notes:

TEXAS WORKFORCE COMMISSION

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