

Participant Resource Guide

Shop Math

September 2026



Course Outline

- Module 1: Basic Operations
- Module 2: Fractions
- Module 3: Decimals

Module 4: Measurements



U.S. Department of Transportation
Federal Transit Administration

A program of the Federal Transit Administration administered by the International Transportation Learning Center

Course: Shop Math

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Shop Math – Measurements

Objectives

- Demonstrate the ability to solve mathematics problems involving measurement.
- Measure and calculate length using appropriate units and tools.
- Calculate the area of surfaces using appropriate formulas and units.
- Solve mathematics problems involving circular objects by calculating diameter, circumference, and area.
- Calculate volume using appropriate formulas and units.

Key Terms

- Area
- Circular Measurement
- Circumference
- Cubic Unit
- Diameter
- Imperial System
- Linear Measurement
- Measurement
- Metric System
- Perimeter
- Radius
- Square Unit
- Volume



Measurements

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Measurements
Shop Math
Transit Core Competencies Curriculum (TC3)

U.S. Department of Transportation
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Agenda

- Welcome and Warm Up
- 4.1 - Linear Measurement
- 4.2 - Area Measurement
- 4.3 - Circular Measurement
- 4.4 - Volume Measurement
- 4.5 – Math and Measurement Activity
- Quiz and Wrap Up

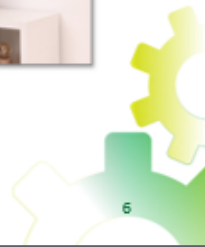


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Warm Up Discussion

Think about a time when you had to measure something at work, at home, or in everyday life.

- What were you measuring?
- What could happen if your measurement was off?
- What did you do to ensure your measurement was accurate?



Notes:

- Think about a time when you had to measure something in your everyday life or on the job.
 - It could be something simple, like measuring a space, hanging a picture, or fitting something into place.
- These are the kinds of situations where measurement skills are important, and they connect directly to what you'll be learning in this module.

What is Measurement?

- **Measurement** is the process of finding out how big, long, heavy, or full something is by using **standard units**.
- Types of measurement: linear, area, circular, volume.
 - ✓ Concept
 - ✓ Units
 - ✓ Tools
 - ✓ Exercises
 - ✓ Real-world applications



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Notes:

- **Measurement** is the process of figuring out how big, long, heavy, or full something is using standard units. In this course, you will focus on four types of measurement: **linear, area, circular, and volume**.
- Each type of measurement helps us understand something different, like length, surface, or space inside an object.
- As you move through the module, you will learn the key concepts behind each type of measurement.
- You will also learn the units used, the tools needed, and how to perform the calculations.
- Most importantly, we will connect these skills to real-world tasks you may perform on the job.
- By the end of this module, you should feel more confident using measurement in practical situations.

Why do Measurements Matter?

- Ensures proper fit and alignment
- Prevents wasted materials
- Supports safety on the job
- Saves time and money
- Helps get the job done right the first time



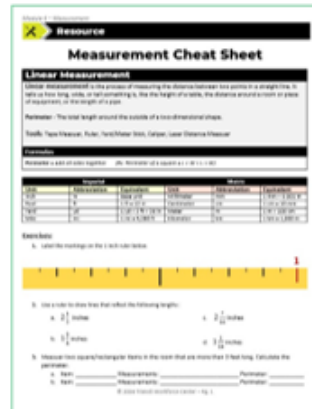
Notes:

- Measurements are something you'll use on almost every job task. Even small errors like being off by half an inch can cause real problems.
- If something doesn't fit correctly, it can lead to rework, delays, or safety risks.
- Accurate measurements help reduce waste, which saves both time and money.
 - This is especially important when materials and labor are expensive.
- At the end of the day, good measurements help you do the job right the first time and a safe and efficient manner.

Measurement Cheat Sheet

In your Participant Resource Guide, you'll find a Measurement Cheat Sheet.

This resource contains helpful notes and exercises we'll complete throughout the lesson.



Notes:

- In your Participant Resource Guide, you'll find a Measurement Cheat Sheet.
- This resource contains helpful notes and exercises you'll complete throughout the lesson.



Measurement Cheat Sheet

Linear Measurement

Linear measurement is the process of measuring the distance between two points in a straight line. It tells us how long, wide, or tall something is, like the height of a table, the distance around a room or piece of equipment, or the length of a pipe.

Perimeter - The total length around the outside of a two-dimensional shape.

Tools: Tape Measuer, Ruler, Yard/Meter Stick, Caliper, Laser Distance Measuer

Formulas

Perimeter = Add all sides together (Ex: *Perimeter of a square* = $L + W + L + W$)

Imperial			Metric		
Unit	Abbreviation	Equivalent	Unit	Abbreviation	Equivalent
Inch	in	Base unit	Millimeter	mm	1 mm = 0.001 m
Foot	ft	1 ft = 12 in	Centimeter	cm	1 cm = 10 mm
Yard	yd	1 yd = 3 ft = 36 in	Meter	m	1 m = 100 cm
Mile	mi	1 mi = 5,280 ft	Kilometer	km	1 km = 1,000 m

Exercises:

1. Label the markings on the 1-inch ruler below.



2. Use a ruler to draw lines that reflect the following lengths :

a. $2\frac{1}{2}$ inches

c. $2\frac{7}{16}$ inches

b. $1\frac{3}{4}$ inches

d. $1\frac{1}{16}$ inches

3. Measure two square/rectangular items in the room that are more than 3 feet long. Calculate the perimeter.

a. Item: _____ Measurements: _____ Perimeter: _____

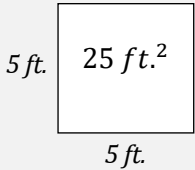
b. Item: _____ Measurements: _____ Perimeter: _____

Area Measurement

Area is the amount of space inside a flat surface. It tells us how many square units fit inside a two-dimensional figure. *Ex:* Flooring in a room, paint on a wall, etc.

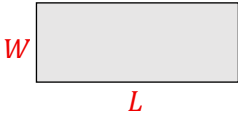
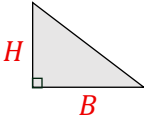
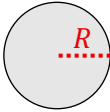
It is measured in **square units**, no matter what the shape.

- Imperial (U.S.)
 - Square inches (in²)
 - Square feet (ft²)
 - Square yards (yd²)
- Metric
 - Square millimeters (mm²)
 - Square centimeters (cm²)
 - Square meters (m²)



Tools: Any tool that can measure length and width (Ex: Tape Measuer, Ruler, etc.)

Formulas

Rectangle/Square	Triangle	Circle
$A = Length \times Width$ 	$A = \frac{1}{2} \times Base \times Height$  *Square in the corner indicates a right angle (90°)	$A = \pi \times radius^2$ 

Exercises:

Choose three objects in the room that are shaped like a square, rectangle, or triangle. If you choose a triangle, make sure it is a right triangle, like the one shown above. Sketch each object using a simple shape, label the measurements, and calculate the area.

1. Object Name:

Sketch:

Equation:
2. Object Name:

Sketch:

Equation:
3. Object Name:

Sketch:

Equation:

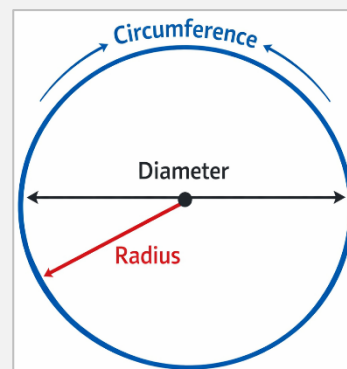
Circular Measurement

Circular measurements are used anytime you are working with round or curved objects.

- **Radius** - Distance from the center to edge
- **Diameter** - Distance across a circle
- **Circumference** - Distance around the outside of a circle
- **Area of a Circle** - Amount of space inside the circle

Units: Radius, Diameter, and Circumference are measured in standard imperial and metric units. Area is measured in square units

Tools: Tape measures, calipers, and flexible tools that can be adjusted to fit circular objects.



Formulas

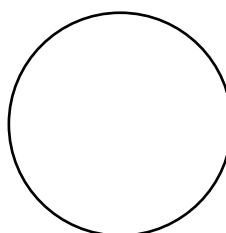
Diameter	Circumference	Area of a Circle
$D = 2 \times \text{radius}$	$C = 2 \times \pi \times \text{radius}$	$A = \pi \times \text{radius}^2$

Exercises:

Choose three circular objects in the room and measure the radius, diameter, and circumference. Next, calculate the area. Label your measurements on the circles below. Your instructor may provide you with some objects to measure.

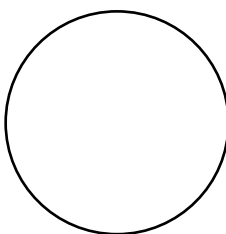
1. Object 1: _____

- Radius - _____
- Diameter - _____
- Circumference - _____
- Area - _____



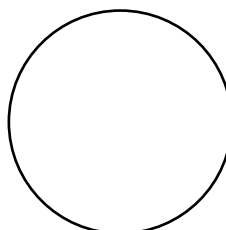
2. Object 2: _____

- Radius - _____
- Diameter - _____
- Circumference - _____
- Area - _____



3. Object 3: _____

- Radius - _____
- Diameter - _____
- Circumference - _____
- Area - _____



Volume Measurement

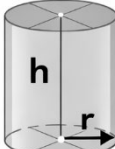
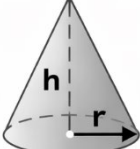
Volume measurements are used to show the amount of space *inside* a three-dimensional object. It tells us how much something can hold.

Units: Cubic units are used to measure volume is because we are measuring three-dimensional spaces.

- Imperial: cubic inches (in³), cubic feet (ft³), cubic yards (yd³), and cubic miles (mi³)
- Metric: cubic centimeters (cm³), cubic meters (m³), and cubic kilometers (km³).

Tools: Tape measures, calipers, and flexible tools that can be adjusted to fit circular objects.

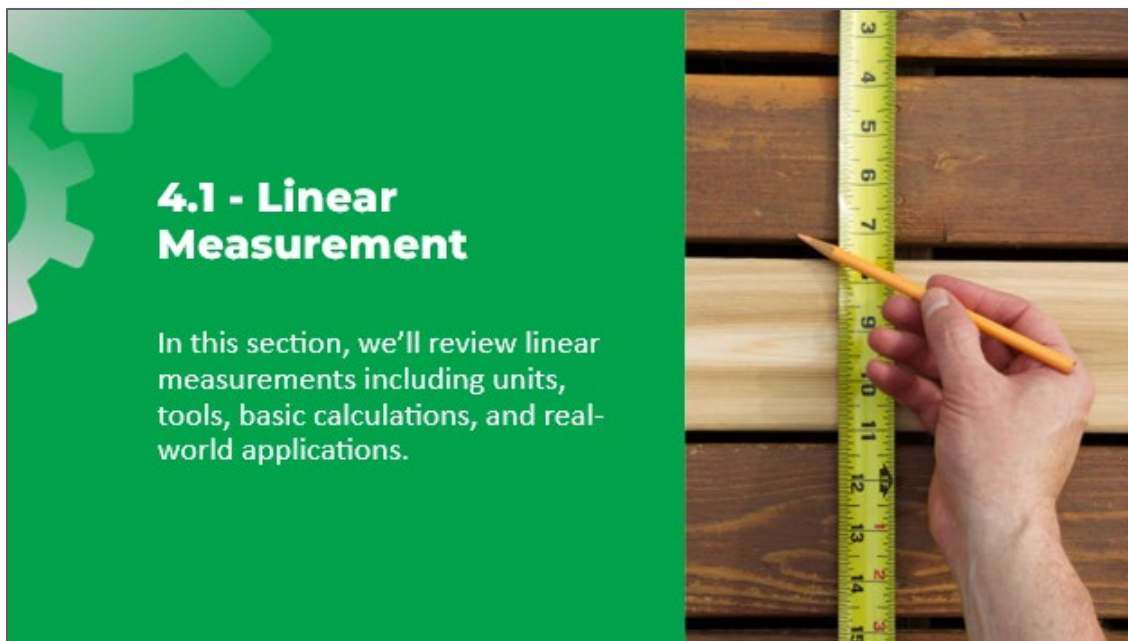
Formulas

Sphere $V = \frac{4}{3} \pi r^3$ 	Rectangular Prism $V = l \times w \times h$ 
Cylinder $V = \pi r^2 \times h$ 	Cone $V = \frac{1}{3} \pi r^2 \times h$ 

Exercises:

Use the formulas in the chart above to solve the word problems below.

1. A maintenance worker needs to fill a rectangular storage bin with sand. The bin is 4 feet long, 3 feet wide, and 2 feet high. How much sand is needed to completely fill the bin?
2. A technician is filling a cylindrical tank with cleaning solution. The tank has a radius of 2 feet and a height of 6 feet. What is the total volume of the tank?
3. A worker is pouring concrete into a rectangular form for an equipment base. The form measures 5 feet long, 4 feet wide, and 1.5 feet deep. How much concrete is needed?
4. A worker is loading equipment into a rectangular storage crate that measures 6 feet long, 2 feet wide, and 3 feet high. What is the total storage capacity of the crate?



Notes:

- In this section, you'll review linear measurements including units, tools, basic calculations, and real-world applications.

Concept

Units

Tools

Exercises

Application

Linear Measurements

- The process of measuring the distance between two points in a straight line.
- It tells us how **tall**, **wide**, or **long** something is.
- **Perimeter** - The total length around the outside of a two-dimensional shape.

Ex: Perimeter of a Square:
 $P = L + W + L + W$



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Notes:

- **Linear measurement** is the process of measuring the distance between two points in a straight line.
 - It tells us how long, wide, or tall something is, like the height of a table, the distance around a room or piece of equipment, or the length of a pipe.
 - Linear measurements can help us calculate the perimeter of a shape.
- **Perimeter** is the total length around the outside of a two-dimensional shape.
- To calculate the perimeter, measure the sides of a share and add all the sides together.
 - For a square or rectangle, the formula would be $P = L + W + L + W$
- What is the perimeter of the room pictured on the slide?

Concept

Units

Tools

Exercises

Application

Linear Measurement Units

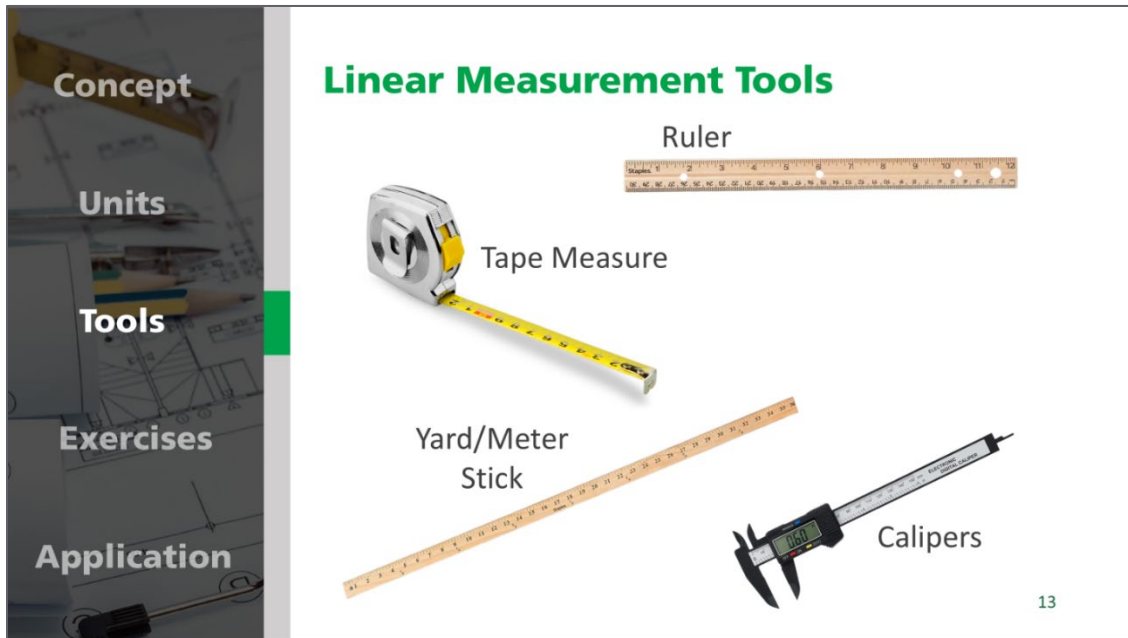
Imperial		
Unit	Abbreviation	Equivalent
Inch	in	Base unit
Foot	ft	1 ft = 12 in
Yard	yd	1 yd = 3 ft = 36 in
Mile	mi	1 mi = 5,280 ft

Metric		
Unit	Abbreviation	Equivalent
Millimeter	mm	1 mm = 0.001 m
Centimeter	cm	1 cm = 10 mm
Meter	m	1 m = 100 cm
Kilometer	km	1 km = 1,000 m

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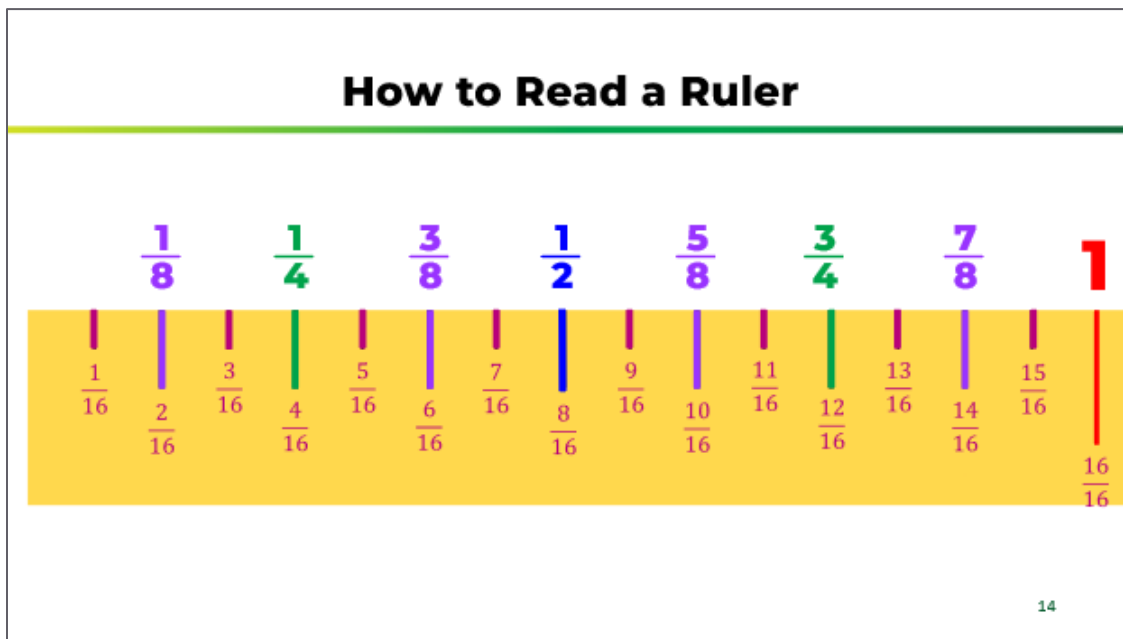
Notes:

- There are two main systems used to measure length: the **imperial system** and the **metric system**.
- The **imperial system** is the standard system used in the United States and measures length using units like inches, feet, yards, and miles.
 - Inches are used for smaller, more precise measurements, while feet are used for larger materials or distances.
 - Yards are used for measuring larger layouts, and miles are used for long distances.
- Each unit builds on the one before it, with 12 inches in a foot and 3 feet in a yard, which helps when converting between units.
- The **metric system** is used in most other countries and is sometimes used in tools and equipment, and it is based on units of 10.
- The metric system includes millimeters, centimeters, meters, and kilometers, which are used for different sizes of measurement.
 - Millimeters and centimeters are used for small measurements, meters are used for general length, and kilometers are used for long distances.
- Even if you mainly use imperial units, it is important to recognize metric units when working with different tools or specifications.
- Being familiar with both systems helps read measurements accurately and avoid mistakes on the job.



Notes:

- There are several tools used to measure length, and each one is designed for a different type of task.
- A **tape measure** is the most commonly used tool in maintenance work because it is flexible and can measure both short and long distances. It has a retractable tape which comes in a variety of lengths (Ex: Small – 3 feet, Large – 40 feet).
- A **ruler** is used for short, precise measurements and is typically used when working with smaller parts or detailed tasks.
- A **yardstick** or **meter stick** is a rigid measuring tool that is useful for measuring longer, flat surfaces.
- **Calipers** are used for very precise measurements and are designed to measure small dimensions with a high level of accuracy. They can measure the outside of an object, the inside of an opening, and the depth of a space, depending on how they are positioned
- A **laser distance measurer** uses a laser to quickly measure longer distances by sending a beam to a surface and calculating how long it takes to return. It provides a digital reading, which makes it easy to read and reduces the chance of error.
- Knowing which tool to use helps you measure accurately and efficiently depending on the task



Notes:

- One of the most useful and widely applicable skills on the job is knowing how to accurately read a ruler or tape measure. Here is a close-up of one inch on a tape measure.
- You'll need to use our understanding of fractions, including simplifying fractions, to accurately read the tape measure.
- There are 16 little lines within the inch. Each of these little lines represents $\frac{1}{16}$. So, you have $\frac{1}{16}$, $\frac{2}{16}$, $\frac{3}{16}$ and so on down the line.
- When we measure something, we're measuring to the nearest 16th. However, these fractions can be *simplified* to make things a bit clearer.
 - Take a look at $\frac{8}{16}$. How could that be simplified?
 - How about $\frac{4}{16}$ and $\frac{12}{16}$. How could those be simplified?
- So, if you measure something that is $5 \frac{8}{16}$ inches, that's the same as saying $5 \frac{1}{2}$. Similarly, if you measure something that is $11 \frac{12}{16}$, that's the same as saying $11 \frac{3}{4}$.
- How about $\frac{2}{16}$, $\frac{6}{16}$, $\frac{10}{16}$ and $\frac{14}{16}$.
 - How could those be simplified?

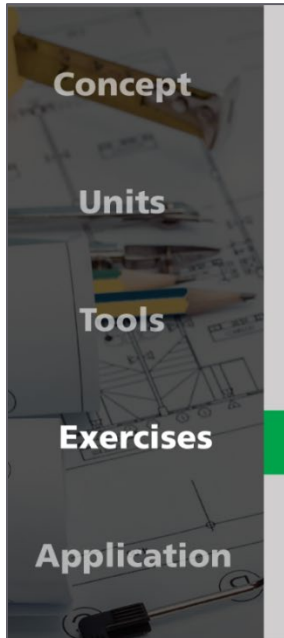


How to Read a Ruler

- **Pause at 09:20**
Complete the practice problems
- **Pause at 12:23**
Complete the practice problems



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Linear Measurement Exercises



Resource

Measurement Cheat Sheet

Linear Measurement

Linear measurement: is the process of measuring the distance between two points in a straight line. It tells us how long, wide, or tall something is, like the height of a table, the distance around a room or piece of equipment, or the length of a pipe.

Perimeter: The total length around the outside of a two-dimensional shape.

Tools: Tape Measure, Ruler, Yard/Meter Stick, Caliper, Laser Distance Measure

Formulas:
 Perimeter = add all sides together (for Perimeter of a square $s + s + s + s = 4s$)

Imperial			Metric		
Unit	Abbreviation	Equivalent	Unit	Abbreviation	Equivalent
Foot	ft	12 in	Centimeter	cm	100 = 1 m
Yard	yd	3 ft = 36 in	Meter	m	1000 = 1 km
Mile	mi	5,280 ft	Kilometer	km	1,000 m

Exercises:

1. Label the markings on the 1 inch ruler below:

2. Use a ruler to draw lines that reflect the following lengths:

a. $2\frac{1}{2}$ inches c. $2\frac{1}{4}$ inches

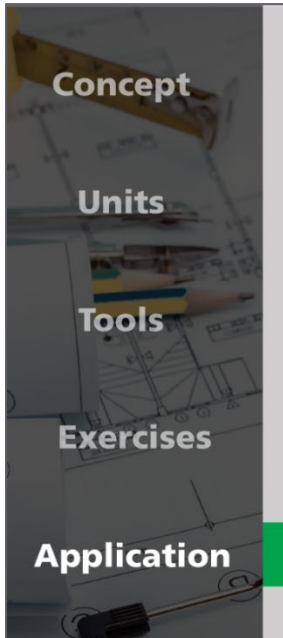
b. $1\frac{3}{4}$ inches d. $1\frac{1}{8}$ inches

3. Measure two square/rectangular items in the room that are more than 2 feet long. Calculate the perimeter.

a. Item: _____ Measurements: _____ Perimeter: _____

b. Item: _____ Measurements: _____ Perimeter: _____

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 Concept Units Tools Exercises Application	Linear Measurement Applications • Measuring and cutting materials to the correct length • Checking spacing and alignment between components • Measuring small parts and clearances for proper fit • Measuring rooms or work areas for layout and planning • Verifying measurements from drawings or specifications 17
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Notes:

- Linear measurement is used in many everyday tasks on the job, especially when accuracy matters.
 - One of the most common uses is measuring and cutting materials to the correct length so they fit properly.
 - It is also used to check spacing and alignment between components to make sure everything is installed correctly.
 - For smaller parts, linear measurement helps ensure proper fit by measuring clearances and dimensions.
 - When planning a workspace, measurements are used to determine how much space is available and where equipment should go. Linear measurement is also used to verify dimensions from drawings or specifications before starting work.
 - Overall, accurate measurement helps prevent mistakes, reduce waste, and ensure the job is done correctly.
-
-
-
-
-

Summary and What's Next

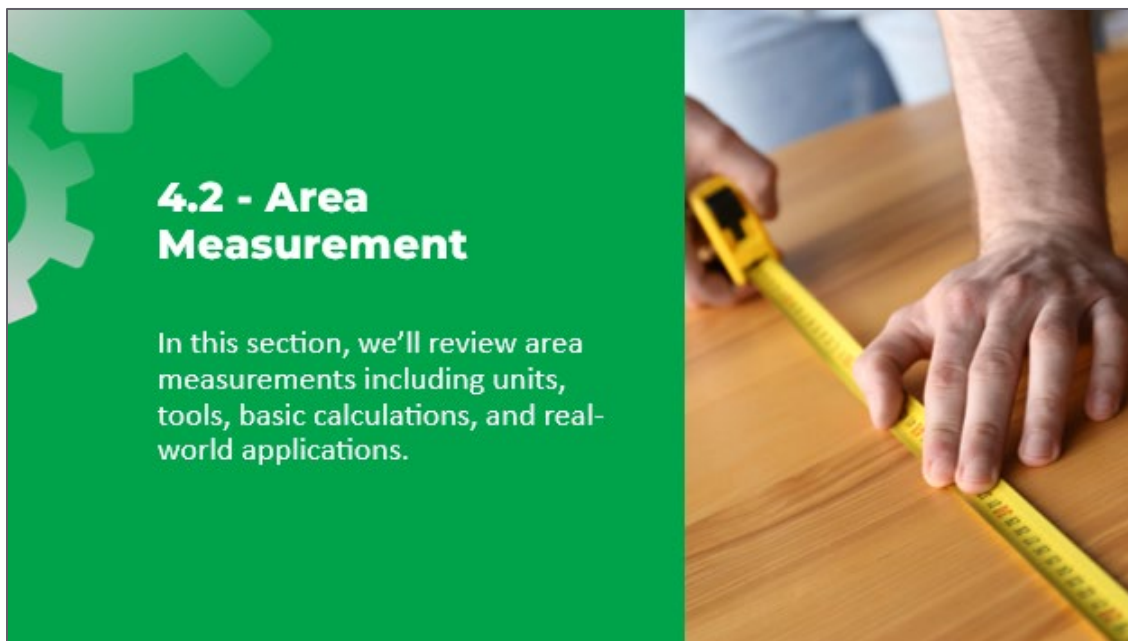
- **Linear measurement** tells us length, width, or height
- Measured using **standard units** like inches and feet
- **Tools** include tape measures, rulers, and laser measurer

Next, we will move from measuring lines to measuring surfaces using area.

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Notes:

- Linear measurement helps determine how long, wide, or tall something is.
- We use standard units like inches and feet, along with tools like tape measures and rulers.
- This type of measurement is used anytime we are working in a straight line.
- Next, you will move from measuring lines to measuring surfaces using area.



Notes:

- In this section, you'll review area measurements including units, tools, basic calculations, and real-world applications.

Concept

Units

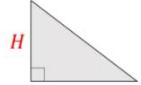
Tools

Exercises

Application

Area Measurement

- **Area** is the amount of space inside a flat surface.
- It tells us how many **square units** fit inside a two-dimensional figure.
 - Ex: Flooring in a room, paint on a wall, etc.

Rectangle/Square	Triangle	Circle
$A = \text{Length} \times \text{Width}$ 	$A = \frac{1}{2} \times \text{Base} \times \text{Height}$ 	$A = \pi \times \text{radius}^2$ 


 Square indicates a right angle (90°)

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Notes:

- **Area** is the amount of space inside a flat surface, and it tells us how much surface something covers. It tells us how many square units fit inside a two-dimensional figure.
- When we measure area, we're really asking: "How many of these 1-by-1 squares can fit inside this shape?"
- This is different from linear measurement because it looks at surface space instead of just length.
- You will use area anytime you need to cover something, like flooring in a room or paint on a wall.
- To calculate area, use formulas based on the shape we are working with.
 - a) For rectangles and squares, we multiply length by width.
 - b) For triangles, we use one-half times the base times the height. When you see a square in the corner of the triangle, that means it's a right angle (90 degrees).
 - c) For circles, we use pi times the radius squared.
- Each formula is designed to match the shape, but they all help answer the same question: how much space does this cover?

Concept

Units

Tools

Exercises

Application

Area Measurement Units

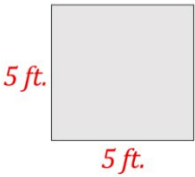
- Measured in **square units**, no matter the shape

Imperial (U.S.)

- Square inches (in²)
- Square feet (ft²)
- Square yards (yd²)

Metric

- Square millimeters (mm²)
- Square centimeters (cm²)
- Square meters (m²)



$A = L \times W$
 $A = 5 \times 5$
 $A = 25 \text{ ft.}^2$

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Notes:

- Area is always measured in square units, no matter the shape we are working with.
- A **square unit** represents a space that is one unit by one unit, like one foot by one foot.
 - In the U.S., we typically use the **imperial system** and commonly use square inches, square feet, and square yards depending on the size of the surface.
- Square inches are used for smaller surfaces, while square feet are used for things like rooms, floors, and walls.
- Square yards are used for larger areas, but less frequently in everyday maintenance tasks.
- The **metric system** also uses square units, including square millimeters, square centimeters, and square meters.
 - Remember, these metric units follow a base-10 system, which makes conversions more straightforward.
 - Looking at the example slide, what would the area of this square be if each side is 5 ft.?
- Notice that the unit is squared, which shows we are measuring surface space, not just length.

Concept

Units

Tools

Exercises

Application

Area Measurement Tools

- Any tool that can measure length and width



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Notes:

- When it comes to tools for calculating area, we can use anything that can measure length and width.
- Rulers, tape measurers, and laser distance measurers can all be useful for identifying length and width to calculate area.

Concept

Units

Tools

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Application

Area Measurement Exercises

Module 4 – Measurement
Resource

Area Measurement

Area is the amount of space inside a flat surface. It tells us how many square units fit inside a two-dimensional figure. Ex: Flooring in a room, paint for a wall, etc.

It is measured in **square units**, no matter what the shape.

Standard (U.S.)

- Square inches (in²)
- Square feet (ft²)
- Square yards (yd²)

Metric

- Square millimeters (mm²)
- Square centimeters (cm²)
- Square meters (m²)

Tools: Any tool that can measure length and width (i.e. Tape Measure, Ruler, etc.)

Formulas:

Shape	Formula
Rectangle	$A = \text{Length} \times \text{Width}$
Triangle	$A = \frac{1}{2} \times \text{Base} \times \text{Height}$
Circle	$A = \pi \times \text{radius}^2$

Exercises:

Choose three objects in the room that are shaped like a square, rectangle, or triangle. If you choose a triangle, make sure it is a right triangle. Use the formulas above. Sketch each object using a graph paper. Label the measurements, and calculate the area.

1. Object Name: _____

Sketch: _____

Equation: _____

2. Object Name: _____

Sketch: _____

Equation: _____

3. Object Name: _____

Sketch: _____

Equation: _____

Measurement Cheat Sheet

of measuring the distance between two points in a straight line. It is the length of a table, the distance around a room or park.

Tools: Ruler, Tape Measure, Laser Distance Measurer

Unit	Conversion	Equation
Feet	Inches	$1 \text{ foot} = 12 \text{ inches}$
Yards	Feet	$1 \text{ yard} = 3 \text{ feet}$
Miles	Feet	$1 \text{ mile} = 5,280 \text{ feet}$
Miles	Yards	$1 \text{ mile} = 1,760 \text{ yards}$
Miles	Meters	$1 \text{ mile} = 1,609 \text{ meters}$

Below:

the following lengths:

c. $2 \frac{1}{4}$ inches

d. $1 \frac{1}{2}$ inches

Three items in the room that are more than 3 feet long:

Measurement: _____

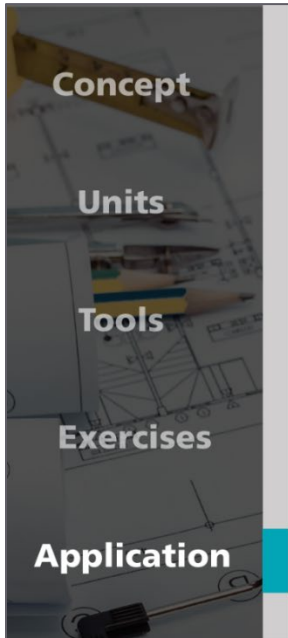
Measurement: _____

Measurement: _____

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	Area Measurement Applications • Calculating how much paint or flooring material is needed to cover a surface • Measuring surface area for cleaning, sealing, or maintenance tasks • Planning workspace layouts to ensure there is enough room for equipment and safe movement • Estimating materials needed for coverings like panels, mats, or insulation 24
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Notes:

- Area measurement is used on the job anytime a surface needs to be covered or planned.
- Workers use area to calculate how much paint or coating is needed for walls, equipment, or other surfaces. It is also used to determine how much flooring material is required for a workspace or maintenance area.
- Area helps estimate materials needed for tasks like covering surfaces with panels, mats, or insulation.
- It is also important for measuring surfaces that need to be cleaned, sealed, or maintained.
- Area is used when planning layouts to make sure there is enough space for equipment and safe movement.

Knowledge Check



A maintenance worker needs to cut a piece of conduit to fit between two connection points that are **42 inches apart**.

Which measurement represents the correct length of the conduit?

(A). 3.5 Ft

(B). 42 square inches

(C). 42 cubic inches

(D). 7 feet

25

Knowledge Check



A worker needs to apply a protective coating to a rectangular metal panel that is **8 feet long** and **5 feet wide**.

How much surface area needs to be covered?

(A). 13 ft

(B). 40 ft squared

(C). 40 ft cubed

(D). 26 ft squared

26

Summary and What's Next

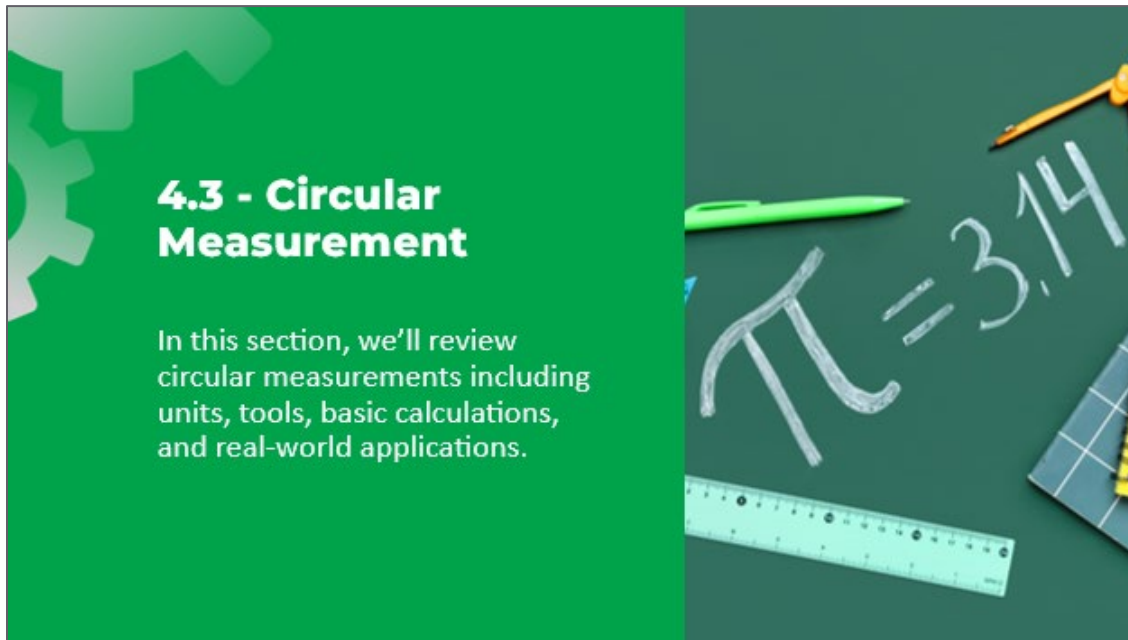
- **Area** measures the space inside a flat surface
- **Calculated** using length $\times$ width
- Always expressed in **square units**

Next, we will look at circular measurement and how to work with round objects.

27

Notes:

- Area tells us how much surface something covers, like a floor or wall.
- We calculate area by multiplying length by width, and the answer is always in square units.
- This is important for tasks like coating, flooring, and planning materials.
- Next, we will look at circular measurement and how to work with round objects.



Notes:

- In this section, you'll review circular measurements including units, tools, basic calculations, and real-world applications.

Concept

Units

Tools

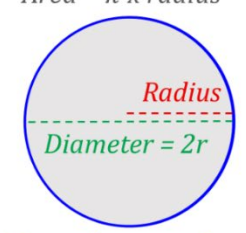
Exercises

Application

Circular Measurement

- **Circular measurements** are used anytime you are working with round or curved objects.
- **Radius** - Distance from center to edge
- **Diameter** - Distance across
- **Circumference** - Distance around the outside
- **Area of a circle** - Space inside

$Area = \pi \times radius^2$



Radius

Diameter = 2r

$Circumference = 2 \pi r$

29

Notes:

- **Circular measurements** are used anytime you are working with round or curved objects.
- To complete calculations involving circles, you need to know the parts of a circle.
 - a) **Radius** is the distance from the center of a circle to the edge.
 - b) **Diameter** is the distance across a circle from one side to the other, passing through the center. To calculate diameter, multiply 2 x the radius.
 - c) **Circumference** is the distance around the outside of a circle. To calculate the circumference, multiply 2 x π x the radius.
- As previously discussed, the **area of a circle** is the amount of space inside the circle.
 - To calculate the area, multiply $\pi \times radius^2$.
- These measurements are common when working with pipes, wheels, cables, and other rounded components.

Concept

Units

Tools

Exercises

Application

Circular Measurement Units

- Radius, Diameter, Circumference
 - Standard Linear Units
 - Imperial: Inches, Feet, Yards
 - Metric: Milli, Centi, Meters
- Area of a Circle
 - Square Units

$C = 18.84 \text{ ft.}$

$R = 3 \text{ ft.}$

$D = 6 \text{ ft.}$

$A = 28.26 \text{ ft.}^2$

30

Notes:

- Radius, diameter, and circumference are all measurements of distance, so they use **standard linear units** like inches, feet, and yards in the imperial system.
 - In the metric system, these measurements use units like millimeters, centimeters, and meters.
 - Even though the shape is a circle, we are still measuring distance, so the units stay the same as linear measurement.
 - Area of a circle is different because it measures the space inside the circle. Because of that, area is always expressed in **square units**, such as square feet.
 - Looking at the example, a circle with a radius of 3 feet, would make the diameter 6 feet.
 - Use the formula on your Cheat Sheets to calculate the circumference and area
 - This shows how the same measurement can lead to different values depending on what you are calculating.
-
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-
-

Concept

Units

Tools

Exercises

Application

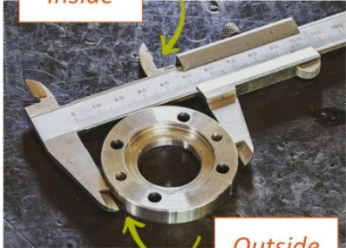
Circular Measurement Tools

- Ruler, tape measure, calipers, etc.

Flexible



Inside



Outside

31

Notes:

- Previously mentioned tools like a ruler, tape measure, and calipers are useful when it comes to circle measurements.
 - Consider using flexible options that can wrap around a pipe or tube to get an accurate measurement.
 - Many calipers have different features on either side to help workers measure the inside or outside of a circular object.
-
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-
-

Concept

Units

Tools

Exercises

Application

Circular Measurement Exercises

Module 4 - Measurement

Resource

Measurement Cheat Sheet

Circular Measurement

Circular measurements are used anytime you are working with round or curved objects.

- **Radius** - distance from the center to edge
- **Diameter** - distance across a circle
- **Circumference** - distance around the outside of a circle
- **Area of a Circle** - Amount of space inside the circle, $A = \pi r^2$

Units: Radius, Diameter, and Circumference are measured in standard imperial and metric units. Area is measured in square units.

Tools: Tape measures, calipers, and flexible tools that can be adjusted to fit circular objects.

Exercises:

Choose three circular objects in the room and measure the radius, diameter, and circumference. Next, calculate the area. Label your measurements on the circles below. Your instructor may provide you with some objects to measure.

1. Object 1:

Radius: _____

Diameter: _____

Circumference: _____

Area: _____

2. Object 2:

Radius: _____

Diameter: _____

Circumference: _____

Area: _____

3. Object 3:

Radius: _____

Diameter: _____

Circumference: _____

Area: _____

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of measuring the distance between two points in a straight line. If A-B, the length of a table, the distance around a room or park.

of Stick, Caliper, Laser Distance Measurer

Imperial	Unit	Approximate	Equivalent
12	Inch	mm	1 in = 25.4 mm
36	Foot	cm	1 ft = 30.5 cm
1.5	Yard	m	1 yd = 91.4 cm
1.6	Foot	m	1 ft = 0.305 m
1.6	Foot	m	1 ft = 0.305 m

below:

the following lengths:

c. $2 \frac{1}{4}$ inches

d. $1 \frac{1}{4}$ inches

one item in the room that are more than 3 feet long

Measurement _____

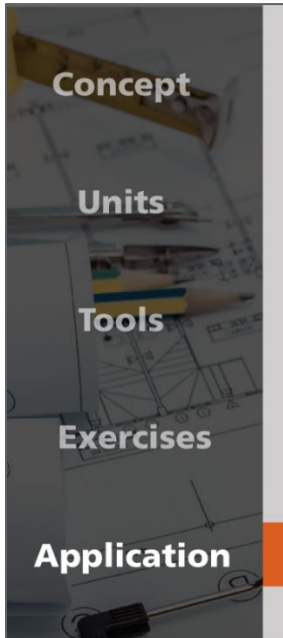
Measurement _____

Measurement _____

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 Concept Units Tools Exercises Application	Circular Measurement Applications • Measuring the diameter of pipes or fittings to ensure proper size and connection • Calculating the circumference of pipes or cables to determine how much material is needed to wrap or cover them • Measuring wheels or rotating parts to check size and proper fit • Estimating materials needed for round covers, gaskets, or components 33
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Notes:

- You will use circular measurements on the job in a variety of ways. Circular measurement is used anytime workers are dealing with round or curved objects on the job.
 - Workers use diameter to measure pipes, fittings, and other circular components to make sure they fit correctly.
 - Circumference is used to determine how much material is needed to wrap around pipes or cables.
 - Circular measurements are also used when working with wheels or rotating parts to check size and alignment.
 - Understanding circular measurements helps ensure proper fit, accurate material use, and safe operation of equipment.
-
-
-
-
-

Summary and What's Next

- **Circular measurements** include radius, diameter, and circumference
- Used for **round objects** like pipes and wheels
- **Area** of a circle uses π and the radius

Next, we will move into volume and learn how to measure space inside objects.

34

Notes:

- Circular measurement is used anytime you are working with round or curved objects.
- You use radius, diameter, and circumference to describe the size and shape of a circle.
- You can also calculate the area of a circle to understand how much surface it covers.
- Next, you will move into volume and learn how to measure space inside objects.



Notes:

- In this section, you'll review volume measurements including units, tools, basic calculations, and real-world applications.

Concept

Units

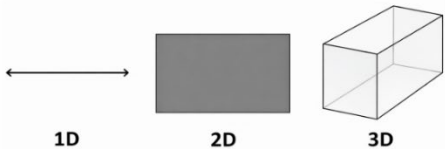
Tools

Exercises

Application

Volume Measurement

- **Volume** is the amount of space inside a three-dimensional object. It tells us how much something can hold.
- Three-dimensions: Length, Width, Height
- Comparison
 - Linear 1D
 - Area 2D
 - Volume 3D

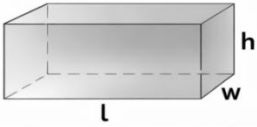


1D 2D 3D

36

Notes:

- **Volume** is the amount of space inside a three-dimensional object, and it tells us how much something can hold. Volume uses three dimensions: **length, width, and height**.
 - All three measurements work together to describe the total space inside an object.
- This is different from linear measurement, which is one-dimensional and measures length.
- Area is two-dimensional and measures surface, while volume is three-dimensional and measures space inside.
- As you move from 1D to 3D, you are adding dimensions and measuring more complex space.
- Understanding this progression helps you choose the right measurement for the task.

Volume Formulas	
Sphere $V = \frac{4}{3} \pi r^3$ 	Rectangular Prism $V = l \times w \times h$ 
Cylinder $V = \pi r^2 \times h$ 	Cone $V = \frac{1}{3} \pi r^2 \times h$ 

37

Notes:

- **Volume formulas** help us calculate how much space is inside different three-dimensional shapes.
- Each shape has its own formula based on its structure and dimensions.
 - a) For a **sphere**, the volume is four-thirds pi times the radius cubed.
 - b) For a **cylinder**, the volume is pi times the radius squared times the height.
 - c) For a **rectangular prism**, the volume is found by multiplying length, width, and height.
 - d) For a **cone**, the volume is one-third pi times the radius squared times the height.
- Even though the formulas look different, they all help us find the same thing, which is the space inside the object.
- Understanding which formula to use depends on recognizing the shape you are working with.

Volume Formulas

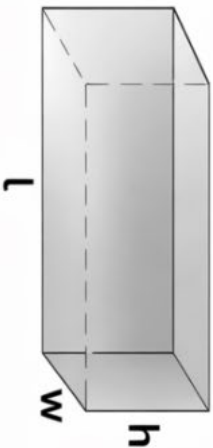
Sphere

$$V = \frac{4}{3} \pi r^3$$



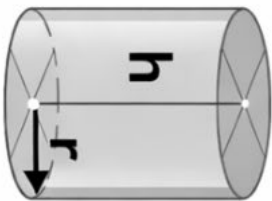
Rectangular Prism

$$V = l \times w \times h$$



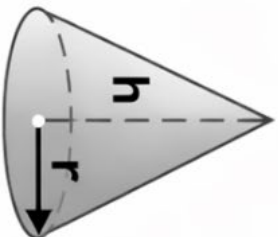
Cylinder

$$V = \pi r^2 \times h$$



Cone

$$V = \frac{1}{3} \pi r^2 \times h$$



Concept

Units

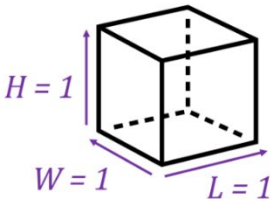
Tools

Exercises

Application

Volume Measurement Units

- **Cubic units** are used to measure volume because we are measuring three-dimensional spaces.
- Imperial: in^3 , ft^3 , yd^3 , and mi^3
- Metric: cm^3 , m^3 , and km^3 .



38

Notes:

- Volume is measured in cubic units because we are measuring space in three dimensions.
- A **cubic unit** represents a cube that is one unit long, one unit wide, and one unit high.
- In the **imperial system**, common units include cubic inches, cubic feet, cubic yards, and cubic miles.
 - Cubic inches are used for very small volumes, while cubic feet are commonly used for spaces and materials.
- In the **metric system**, common units include cubic centimeters, cubic meters, and cubic kilometers.
- Remember, metric units are based on powers of ten, which makes them easier to convert between.

Concept

Units

Tools

Exercises

Application

Volume Measurement Tools

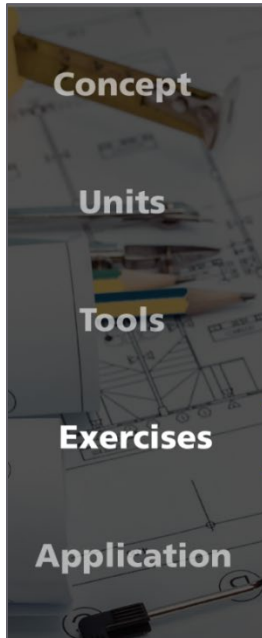
- Ruler, tape measure, calipers, etc.



39

Notes:

- Much like circular and area measurements, we need basic measuring tools to calculate volume.
 - This includes rulers, tape measures, calipers, etc.
 - Remember that when measuring cylindrical items like pipes, a flexible tape measure may be most useful.
-
-
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Volume Measurement Exercises

✖ Resource

Measurement Cheat Sheet

Volume Measurement

Volume measurements are used to show the amount of space inside a three-dimensional object. It tells us how much something can hold.

Units: Cubic units are used to measure volume because we are measuring three-dimensional spaces.

- Imperial: cubic inches (in³), cubic feet (ft³), cubic yards (yd³), and cubic miles (mi³)
- Metric: cubic centimeters (cm³), cubic meters (m³), and cubic kilometers (km³)

Tools: Tape measures, calipers, and flexible tools that can be adjusted to fit circular objects.

Formulas

Object	Formula
Sphere	$V = \frac{4}{3} \pi r^3$
Cylinder	$V = \pi r^2 h$
Rectangular Prism	$V = l \times w \times h$
Cone	$V = \frac{1}{3} \pi r^2 h$

Exercises:

Use the formulas in the chart above to solve the word problems below:

1. A maintenance worker needs to fill a rectangular storage bin with sand. The bin is 4 feet long, 3 feet wide, and 2 feet high. How much sand is needed to completely fill the bin?
2. A technician is filling a cylindrical tank with cleaning solution. The tank has a radius of 2 feet and a height of 8 feet. What is the total volume of the tank?
3. A worker is pouring concrete into a rectangular form for an equipment base. The form measures 5 feet long, 4 feet wide, and 1.5 feet deep. How much concrete is needed?
4. A worker is loading equipment into a storage crate that measures 6 feet long, 2 feet wide, and 3 feet high. What is the total storage capacity of the crate?

Distance between two points in a straight line. It tells the distance around a room or space.

Distance Measurer

Measurement	Unit
1 inch	1 in
1 foot	1 ft = 12 in
1 yard	1 yd = 3 ft = 36 in
1 mile	1 mi = 1,760 yd = 5,280 ft = 63,360 in

1

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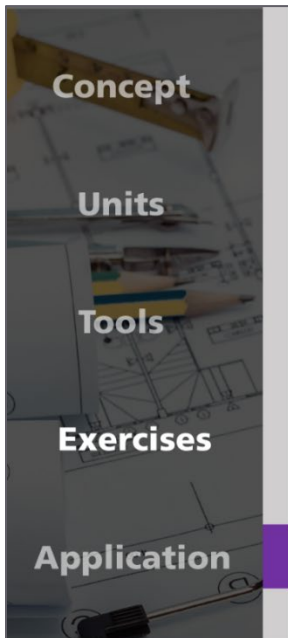
98. 1 $\frac{1}{2}$ inches

99. 1 $\frac{1}{2}$ inches

100. 1 $\frac{1}{2}$ inches

40

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	Volume Measurement Applications • Determining how much liquid a container or tank can hold • Calculating how much material is needed to fill a space, such as concrete, gravel, or soil • Measuring storage capacity for bins, containers, or compartments 41
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Notes:

- Volume measurement is used anytime workers need to know how much space something can hold or contain.
- Workers use volume to determine how much liquid a tank or container can hold.
 - It is also used to calculate how much material is needed to fill a space, such as concrete or gravel.
- Volume helps measure storage capacity for containers, bins, and compartments.
 - It is used to estimate how much fluid is needed for systems like cooling or cleaning.
- Volume measurement also helps when packing or storing equipment to make sure there is enough space available.

Knowledge Check



A worker needs to measure the distance around a pipe to determine how much insulation material is needed.

Which tool is the best choice for this task?

(A). Ruler

(B). Caliper

(C). Tape Measurer

(D). Laser Distance Measurer

42

Knowledge Check



A worker is filling a rectangular container that is **4 feet long**, **3 feet wide**, and **2 feet high**.

What is the volume of the container?

(A). 9 ft. squared

(B). 24 ft. cubed

(C). 24 ft.

(D). 12 ft. cubed

43

Summary and What's Next

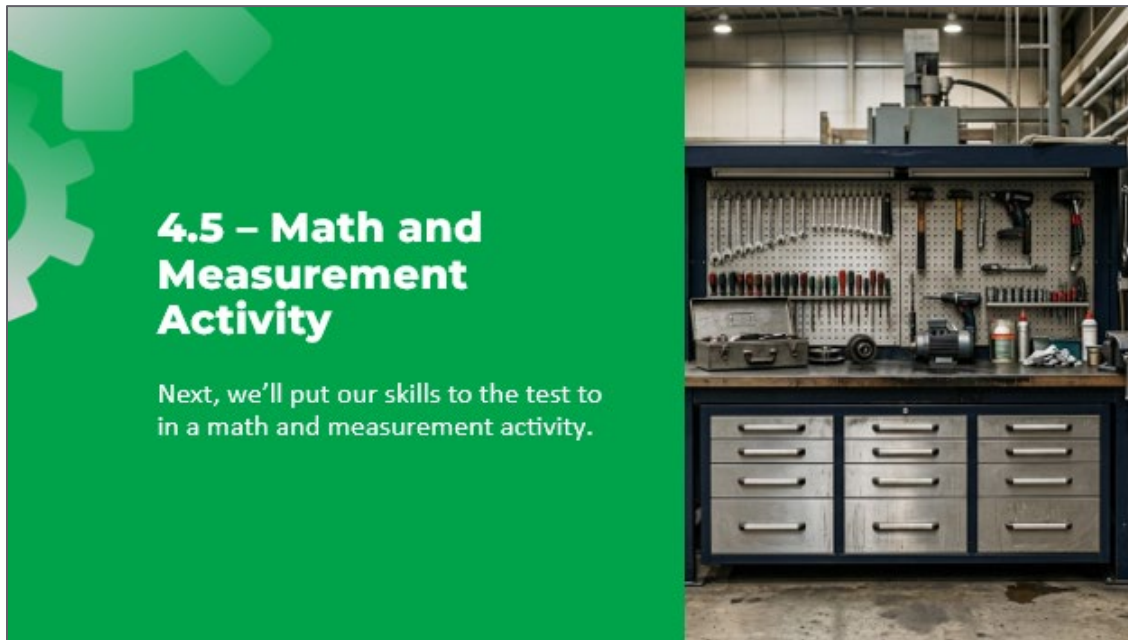
- **Volume** measures the space inside a 3D object
- **Calculated** using length, width, and height
- Expressed in **cubic units**

Next, you will apply everything you've learned in the Maintenance Math Challenge.

44

Notes:

- Volume tells you how much space something can hold or contain.
- You calculate volume using three dimensions: length, width, and height.
- The answer is always in cubic units because you are measuring three-dimensional space.
- Next, you will apply everything you've learned in the Maintenance Math Challenge.



Notes:

- Next, you'll put our skills to the test in a math and measurement activity

Math and Measurement Challenge



Scenario: Your team has been assigned to prepare a new maintenance workstation area inside a transit facility. Use your math and measurement skills to ensure proper fit, avoid wasted materials, and stay within the project budget. Be sure to show your work, use correct measurements, and round decimals to the nearest tenth when needed.

(1) Complete questions 1-5 with a partner.

(2) Sketch the workstation on the back of this handout and label the bolded items. Be sure to include both the name and number in your label.

The thumbnail shows a worksheet titled 'Maintenance Math and Measurement Challenge'. It includes instructions for students to work in pairs, use math and measurement skills, and show their work. The worksheet contains five numbered questions with multiple-choice options. The questions are:

- The workstation area is 10 feet long and 12 feet wide. Calculate the perimeter of the area.
 - Calculate the perimeter.
 - Calculate the area.
 - Calculate the length of the area.
 - Calculate the width of the area.
- The floor of the workstation area will be covered with carpeting material.
 - Calculate the area of the workstation.
 - Calculate the perimeter of the workstation.
 - Calculate the length of the workstation.
 - Calculate the width of the workstation.
- A double door will be installed in the side of the workstation. The width of the door is 3 feet.
 - Calculate the perimeter of the workstation.
 - Calculate the area of the workstation.
 - Calculate the length of the workstation.
 - Calculate the width of the workstation.
- The workstation area will be filled with carpeting. The carpet is 12 feet long, 12 feet wide, and 12 feet high.
 - Calculate the area of the workstation.
 - Calculate the perimeter of the workstation.
 - Calculate the length of the workstation.
 - Calculate the width of the workstation.

At the bottom of the worksheet, there is a section for 'Show Your Work' with three columns for calculations.



Activity

Maintenance Math and Measurement Challenge

Scenario: Your team has been assigned to prepare a new maintenance workstation area inside a transit facility. Use your math and measurement skills to ensure proper fit, avoid wasted materials, and stay within the project budget. Be sure to show your work, use correct measurements, and round decimals to the nearest tenth when needed.

(1) Complete questions 1-5 with a partner. **(2)** Sketch the workstation on the back of this handout and label the bolded items. Be sure to include both the name and number in your label (Ex: *Cable* - __ yards).

1. The workstation area is 18 feet long and 12 feet wide. A **cable** must run along the perimeter of the area.
 - a. Calculate the total perimeter - _____
 - b. Convert the total length into yards - _____

2. The floor of the workstation area will be coated with a **protective material**.
 - a. Calculate the total area of the workspace - _____

3. A **circular pipe** base will be installed in the center of the workstation. The **radius** of the base is 2 feet.
 - a. Calculate the diameter - _____
 - b. Calculate the circumference - _____
 - c. Calculate the area of the circle - _____

4. The workstation pad will be filled with **concrete**. The pad is 18 feet long, 12 feet wide, and 0.5 feet deep.
 - a. Calculate the volume of concrete needed - _____

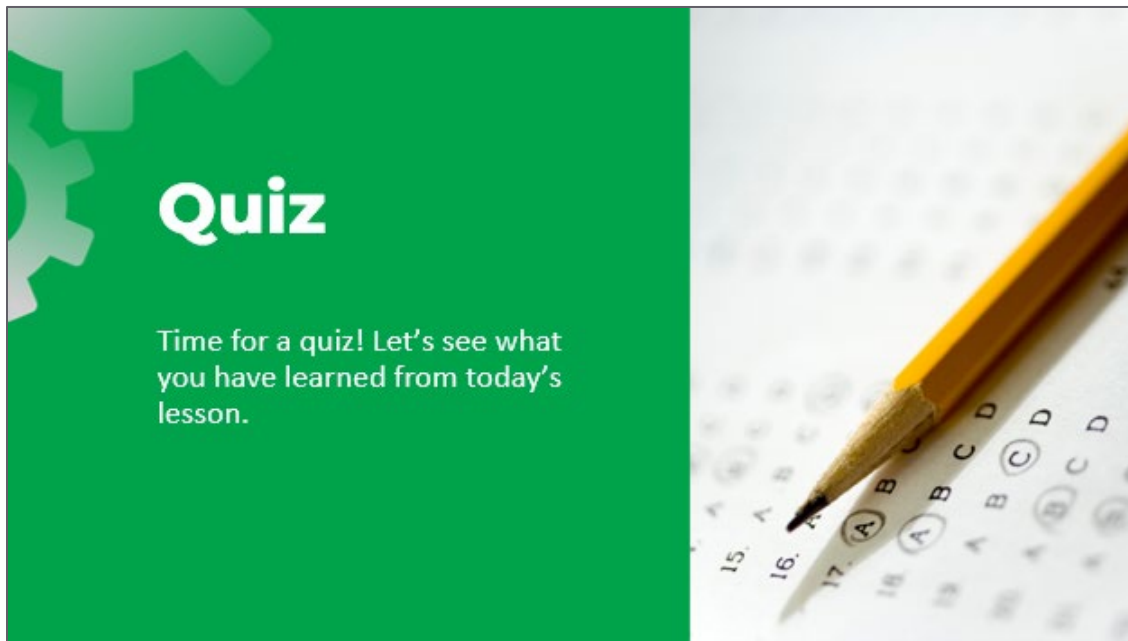
5. Use the following costs to estimate the total project cost:

\$ Concrete = \$4.75 per cubic foot	\$ Floor coating = \$1.85 per square foot	\$ Cable = \$2.40 per foot
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Shop Math – Measurements

- a. Calculate the cost of concrete - _____
- b. Calculate the cost of floor coating - _____
- c. Calculate the cost of cable - _____
- d. Calculate the total project cost - _____

Reminder - Sketch the workstation below and label the bolded items in #1-4. Be sure to include both the name and number in your label (Ex: *Cable* - __ yards).



Notes:

- Time for a quiz! Let's see what you have retained from today's lesson.

Revisiting Objectives

- Demonstrate the ability to solve mathematics problems involving measurement.
 - Measure and calculate length using appropriate units and tools.
 - Calculate the area of surfaces using appropriate formulas and units.
 - Solve mathematics problems involving circular objects by calculating diameter, circumference, and area.
 - Calculate volume using appropriate formulas and units.

48

Notes:

- If you were explaining today's objectives to someone else, how would you summarize what they mean and why they matter?
- Which of today's objectives do you feel most confident about? Which were most challenging?
 - Explain your reasoning.
- Can you give an example of how you could apply one of today's objectives in a real-world situation?
