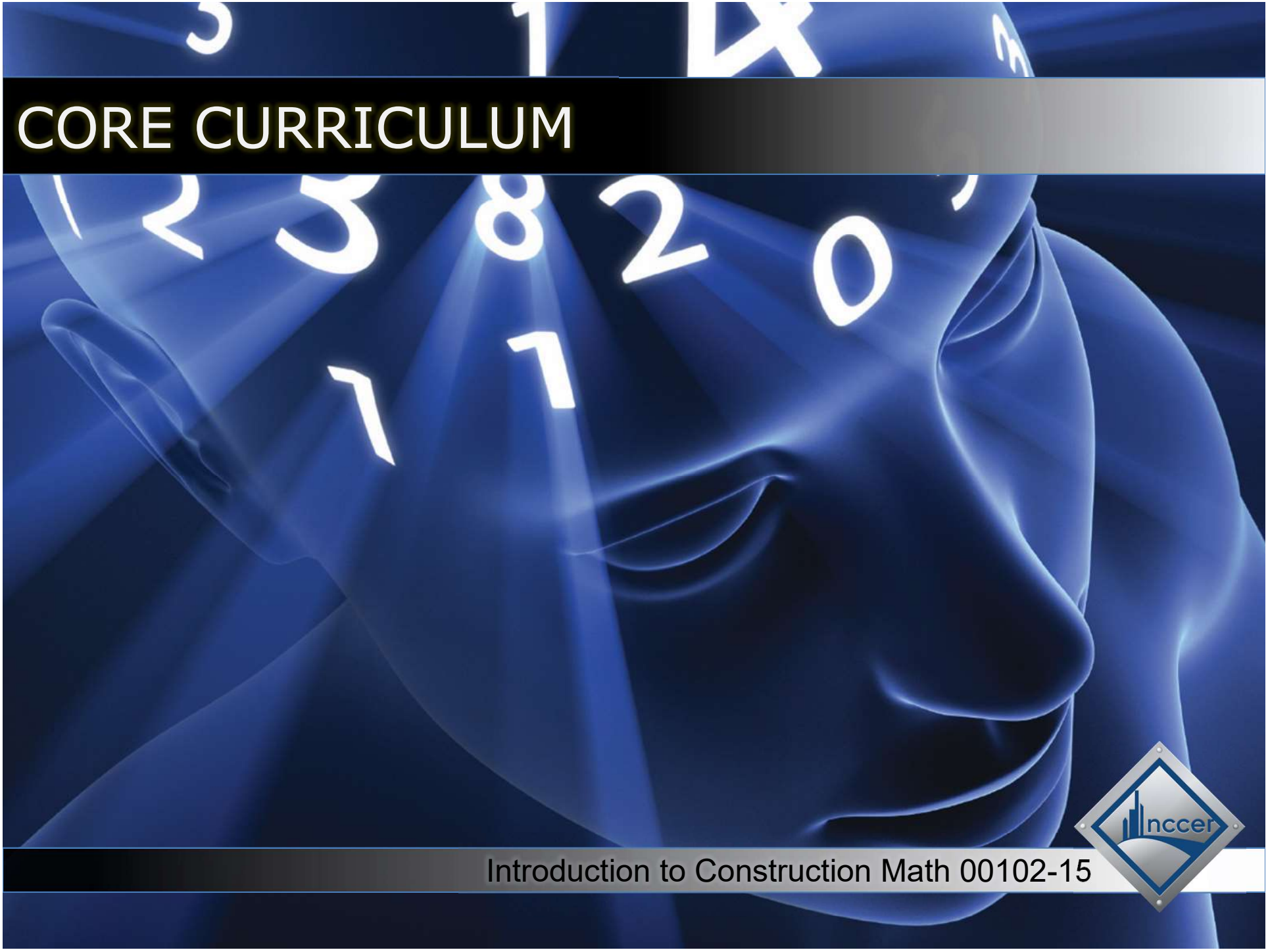
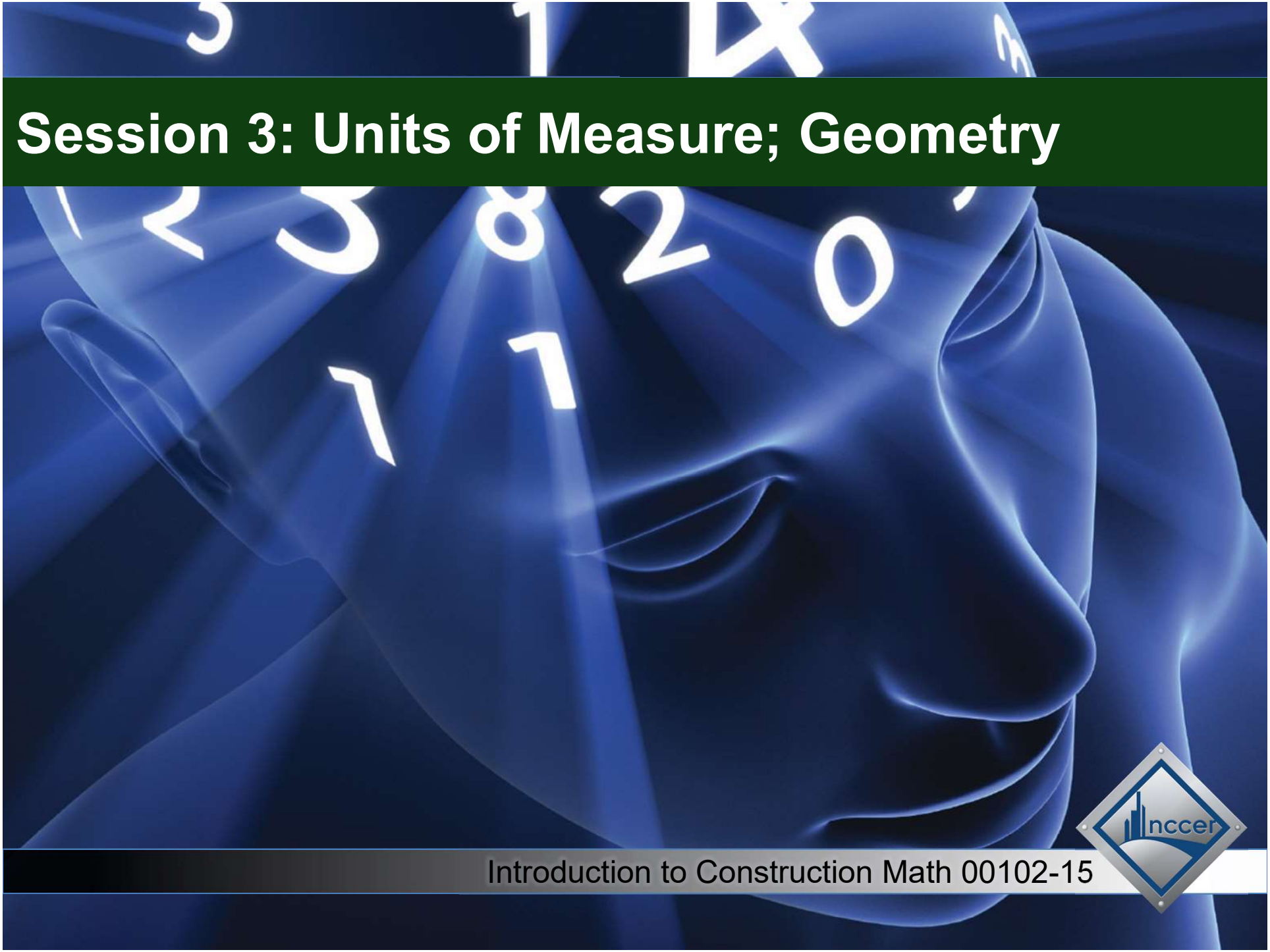
CORE CURRICULUM



Introduction to Construction Math 00102-15

Session 3: Units of Measure; Geometry



Introduction to Construction Math 00102-15

Session Three Objectives

When trainees have completed this session, they should be able to do the following:

5. Identify and convert units of length, weight, volume, and temperature between the imperial and metric systems of measurement.
   a. Identify and convert units of length measurement between the imperial and metric systems.
   b. Identify and convert units of weight measurement between the imperial and metric systems.
   c. Identify and convert units of volume measurement between the imperial and metric systems.
   d. Identify and convert units of temperature measurement between the imperial and metric systems.

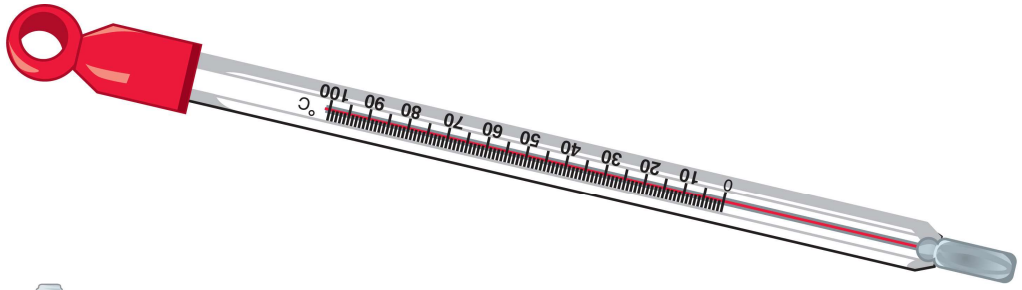
Session Three Objectives

When trainees have completed this session, they should be able to do the following:

6. Identify basic angles and geometric shapes and explain how to calculate their area and volume.
   a. Identify various types of angles.
   b. Identify basic geometric shapes and their characteristics.
   c. Demonstrate the ability to calculate the area of two-dimensional shapes.
   d. Demonstrate the ability to calculate the volume of three-dimensional shapes.

Section 5.0.0 – Units of Measure

These metric units of measure are seen worldwide on packaging and in other common places on a daily basis.

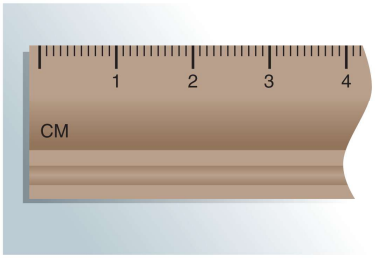


ICE CUBES FREEZE AT 0° CELSIUS
VERSUS 32° FAHRENHEIT

CELSIUS = TEMPERATURE

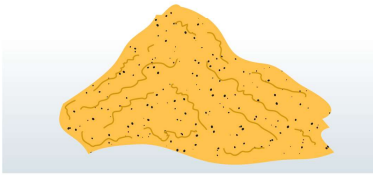
A 2-LITER BOTTLE OF SODA
INSTEAD OF A HALF-GALLON

LITERS = VOLUME



A METER STICK
INSTEAD OF A YARDSTICK

METERS = LENGTH



A GRAM OF GOLD
INSTEAD OF AN OUNCE

GRAMS = WEIGHT

00102-15_F19.EPS

Section 5.0.0 – Units of Measure

Although each prefix applies to every unit of measure, many units are virtually ignored for convenience. For example, the unit dekameter is rarely used, while centimeters and kilometers are extremely common. But a dekameter is a valid unit that can be used if desired.

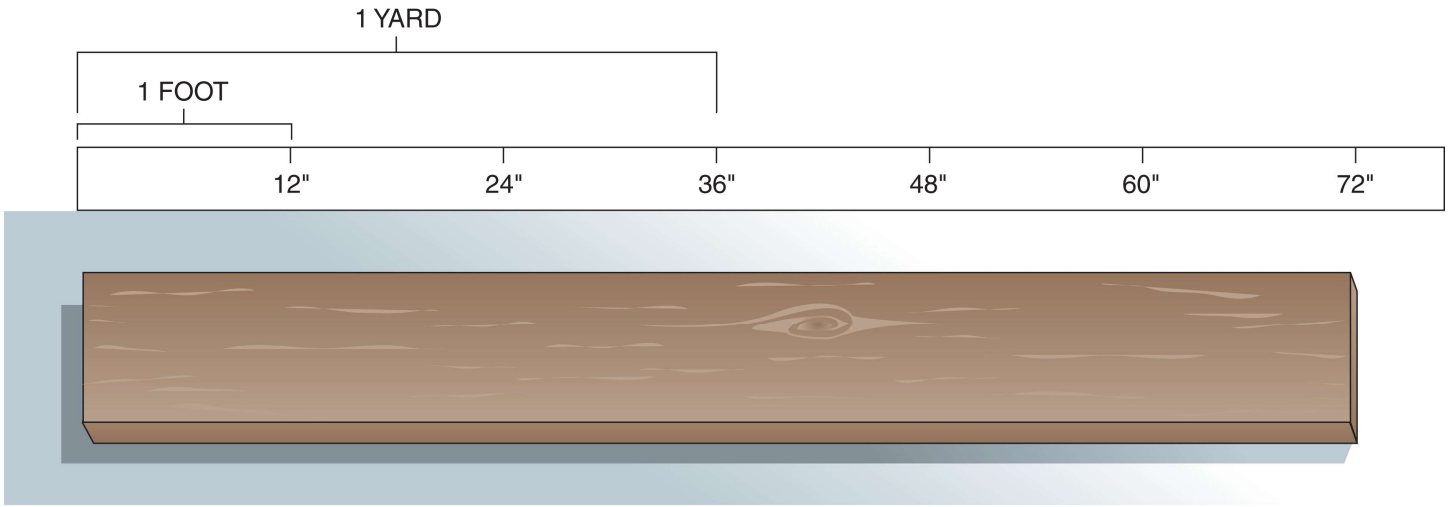
Prefix	Unit			
micro- (μ)	1/1,000,000	0.000001	10^{-6}	One-millionth
milli- (m)	1/1,000	0.001	10^{-3}	One-thousandth
centi- (c)	1/100	0.01	10^{-2}	One-hundredth
deci- (d)	1/10	0.1	10^{-1}	One-tenth
deka- (da)	10	10.0	10^{1}	Tens
hecto- (h)	100	100.0	10^{2}	Hundreds
kilo- (k)	1,000	1,000.0	10^{3}	Thousands
mega- (M)	1,000,000	1,000,000.0	10^{6}	Millions
giga- (G)	1,000,000,000	1,000,000,000.0	10^{9}	Billions

00102-15_T01.EPS

Sections 5.1.1 and 5.1.2 – Units of Measure

IMPERIAL LENGTH UNITS		
1 inch	=	$\frac{1}{12}^{th}$ of a foot; 0.0833 feet
1 foot	=	12 inches; $\frac{1}{3}^{rd}$ of a yard
1 yard	=	36 inches; 3 feet
1 mile	=	5,280 feet; 1,760 yards

00102-15_T02.EPS

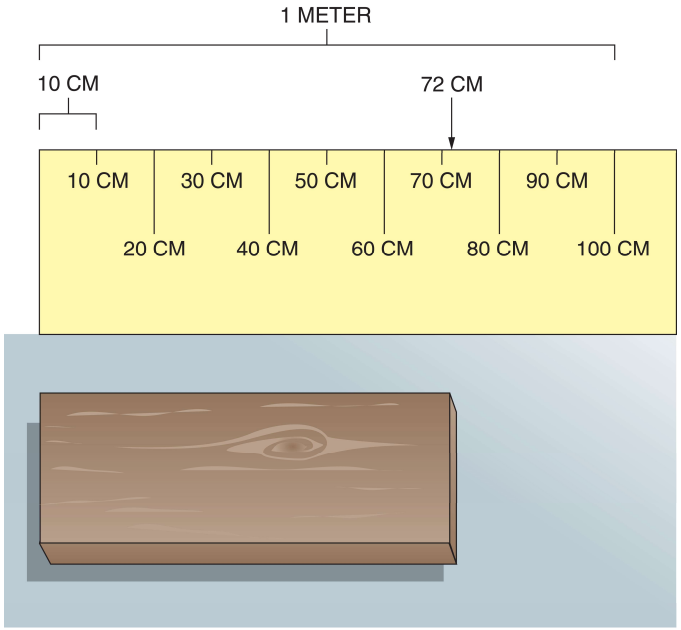


00102-15_F20.EPS

Sections 5.1.1 and 5.1.2 – Units of Measure

METRIC LENGTH UNITS		
1 kilometer	=	1,000 meters
1 meter	=	100 centimeters; 0.001 kilometers
1 centimeter	=	10 millimeters; 0.01 meters
1 millimeter	=	0.1 centimeters; 0.001 meters

00102-15_T03.EPS



00102-15_F21.EPS

Sections 5.1.3 and 5.1.4 – Units of Measure

Unit	Centimeter	Inch	Foot	Meter	Kilometer
1 millimeter	0.1	0.03937	0.003281	0.001	0.000001
1 centimeter	1	0.3937	0.3281	0.01	0.00001
1 inch	2.54	1	0.08333	0.0254	0.0000254
1 foot	30.48	12	1	0.3048	0.0003048
1 meter	100	39.37	3.281	1	0.001
1 kilometer	100,000	39,370	3,281	1,000	1

00102-15_T04.EPS

Find the answers to the following conversion problems without using a calculator.

1. 0.45 meter = **45** centimeters
2. 3 yards = **108** inches
3. 36 feet = **12** yards

Sections 5.2.1 and 5.2.2 – Units of Measure

Note that the ton in the imperial system is also known as the short ton. The long ton is rarely used, except in describing ship displacement, and is equal to 2,240 pounds.

IMPERIAL WEIGHT UNITS		
1 ounce	=	$\frac{1}{16}^{th}$ of a pound; 0.0625 pounds
1 pound	=	16 ounces; 0.0005 tons
1 ton	=	2,000 pounds

00102-15_T05.EPS

METRIC WEIGHT UNITS		
1 metric ton	=	1,000 kilograms
1 kilogram	=	1,000 grams; 0.001 metric tons
1 gram	=	1,000 milligrams; 0.001 kilograms
1 milligram	=	0.001 gram; 0.000001 kilograms

00102-15_T06.EPS

Sections 5.2.3 and 5.2.4 – Units of Measure

IMPERIAL AND METRIC WEIGHT CONVERSION							
Unit	**Metric Ton**	**Ton**	**Kilogram**	**Pound**	**Ounce**	**Gram**	**Milligram**
1 metric ton	1	1.102	1,000	2,204.62	35,274	1,000,000	1,000,000,000
1 ton	0.9072	1	907.185	2,000	32,000	907,185	907,200,000
1 kilogram	0.001	0.0011	1	2.205	35.27	1,000	1,000,000
1 pound	0.000454	0.0005	0.4536	1	16	453.6	453,592
1 ounce	0.00002835	0.00003125	0.02835	0.0625	1	28.35	28,349.5
1 gram	0.000001	0.000001102	0.001	0.002205	0.03527	1	1,000
1 milligram	0.000000001	0.000000001102	0.000001	0.000002205	0.00003527	0.001	1

00102-15_T07.EPS

Convert these weights from imperial to metric weight units, or vice versa.

1. 50 pounds = **22.68** kilograms
2. 50 kilograms = **110.23** pounds
3. 15.9 ounces = **450.76** grams

Sections 5.3.1 and 5.3.2 – Units of Measure

Note that these volume units are not related to liquid measures such as the gallon and the liter.

IMPERIAL VOLUME UNITS		
1 cubic inch	=	0.0005787 cubic feet
1 cubic foot	=	1,728 cubic inches; 0.037 cubic yards
1 cubic yard	=	27 cubic feet

00102-15_T08.EPS

METRIC VOLUME UNITS		
1 cubic centimeter	=	0.000001 cubic meters
1 cubic meter	=	1,000,000 cubic centimeters

00102-15_T09.EPS

Sections 5.3.3 and 5.3.4 – Units of Measure

IMPERIAL AND METRIC VOLUME CONVERSION

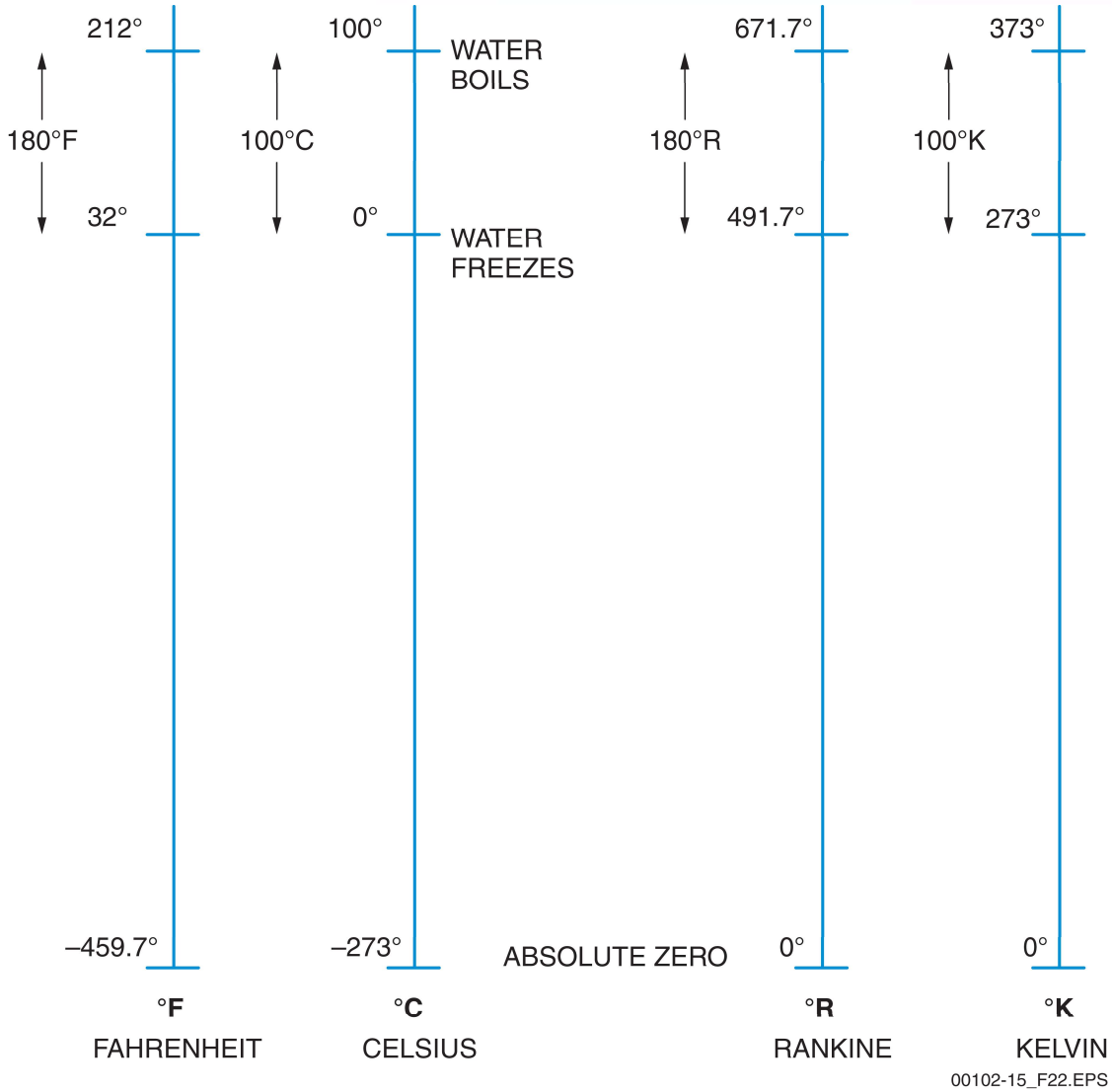
Unit	Cubic Meter	Cubic Yard	Cubic Foot	Cubic Inch	Cubic Centimeter
1 cubic meter	1	1.308	35.315	61,023.7	1,000,000
1 cubic yard	0.765	1	27	46,656	764,554.86
1 cubic foot	0.0283	0.037	1	1,728	28,316.85
1 cubic inch	0.000016387	0.000021433	0.0005787	1	16.387
1 cubic centimeter	0.000001	0.000001308	0.00003531	0.0610	1

00102-15_T10.EPS

Convert these volumes from the imperial system to the metric system, or vice versa.

1. 11,600 cubic inches = **6.7** cubic feet
2. 1.9 cubic meters = **1,900,000** cubic centimeters
3. 512 cubic meters = **669.7** cubic yards

Section 5.4.0 – Units of Measure



00102-15_F22.EPS

Section 5.4.0 – Units of Measure

Degrees C = 5/9 (degrees F – 32)

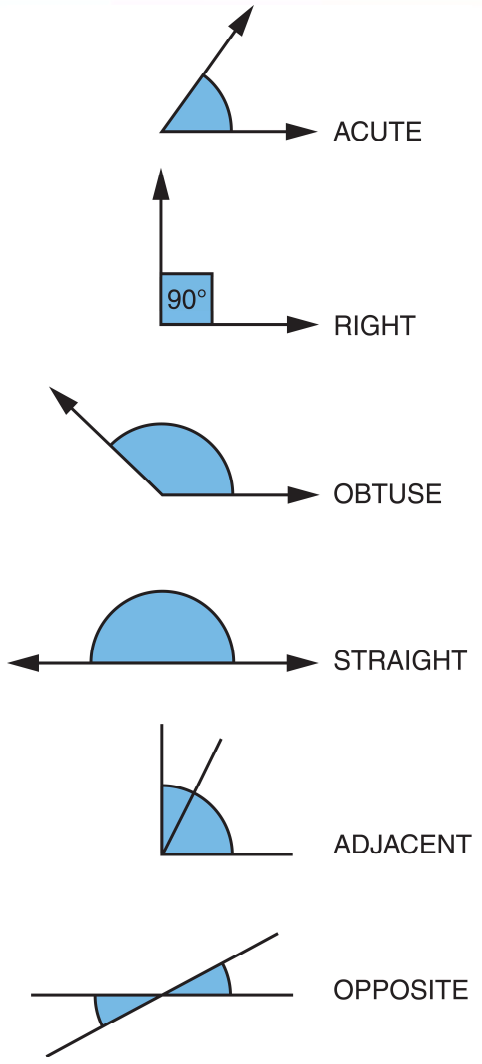
Degrees F = (9/5 × degrees C) + 32

Convert these temperatures from Fahrenheit to Celsius, or vice versa.

1. 180 degrees F = **82.2** C
2. 66 degrees F = **18.9** C
3. –26 degrees C = **–14.8** F

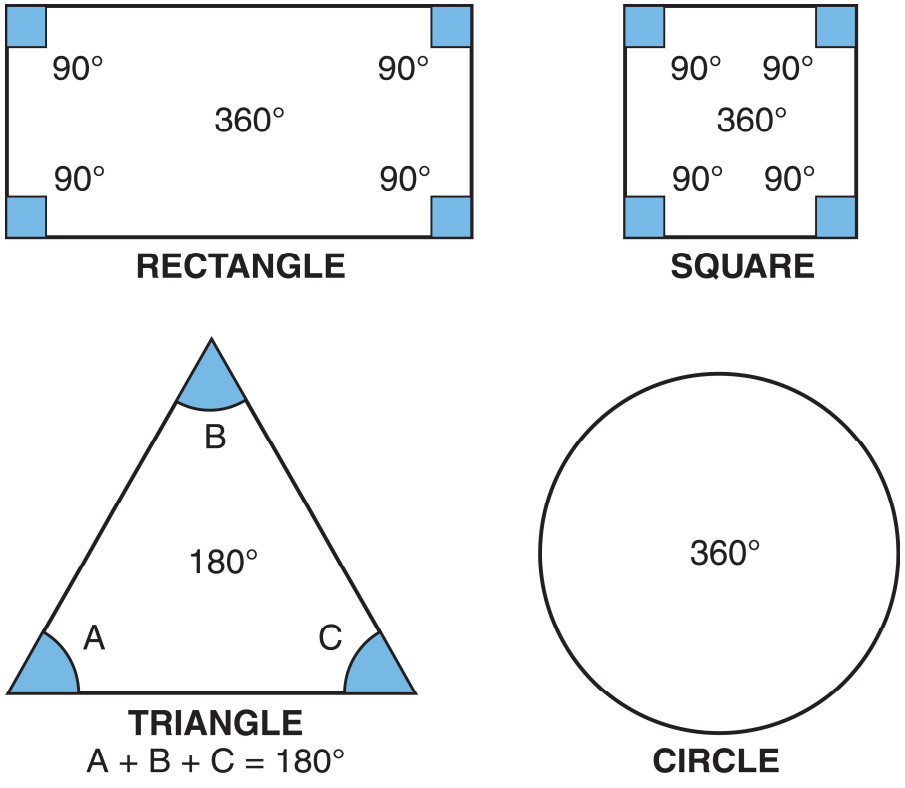
Sections 6.1.0 and 6.2.0 – Geometry

A right angle is neither obtuse nor acute. Adjacent and opposite angles are two or more angles together.



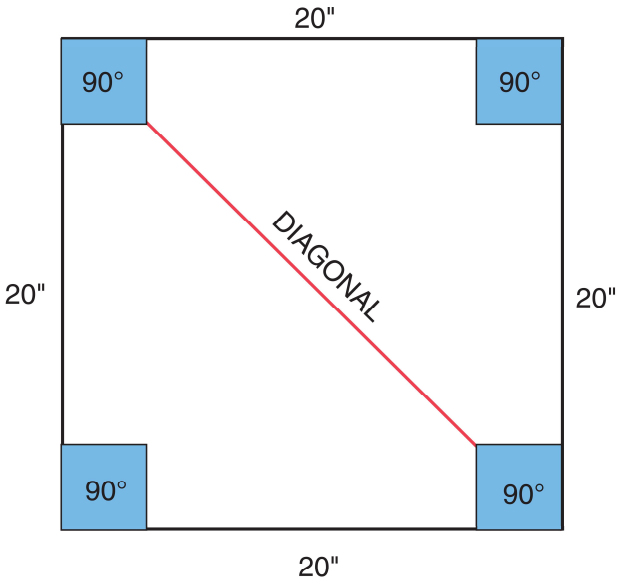
Sections 6.1.0 and 6.2.0 – Geometry

Note that the combined angles of the triangle are equal to 180 degrees, not 360 degrees.

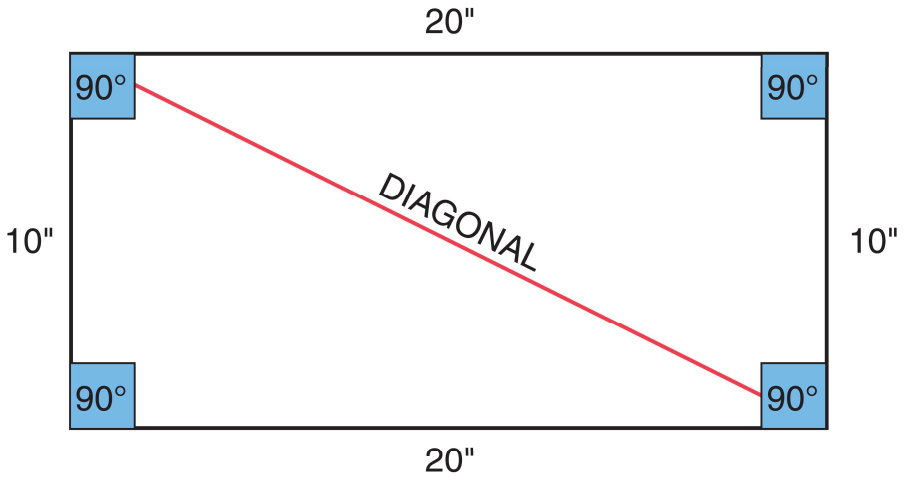


Sections 6.2.1 and 6.2.2 – Fractions

Diagonals create two equal right triangles in each of these shapes. However, with a square, each of the other two angles in each triangle will be exactly 45 degrees. With a rectangle, those angles depend on the rectangle length, but they will *not* be 45 degrees unless it is a square!



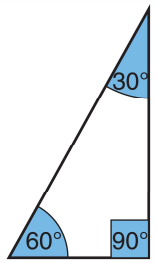
00102-15_F27.EPS



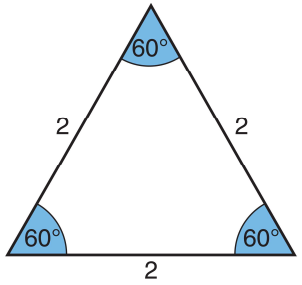
00102-15_F26.EPS

Sections 6.2.3 and 6.2.4 – Geometry

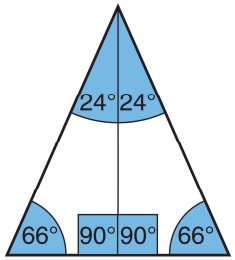
Understanding triangles is extremely important for pipefitters and workers in numerous other crafts.



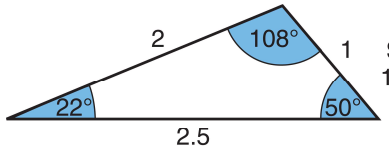
RIGHT TRIANGLE
30° + 60° + 90° = 180°



EQUILATERAL TRIANGLE
60° + 60° + 60° = 180°



ISOSCELES TRIANGLE
48° + 66° + 66° = 180°

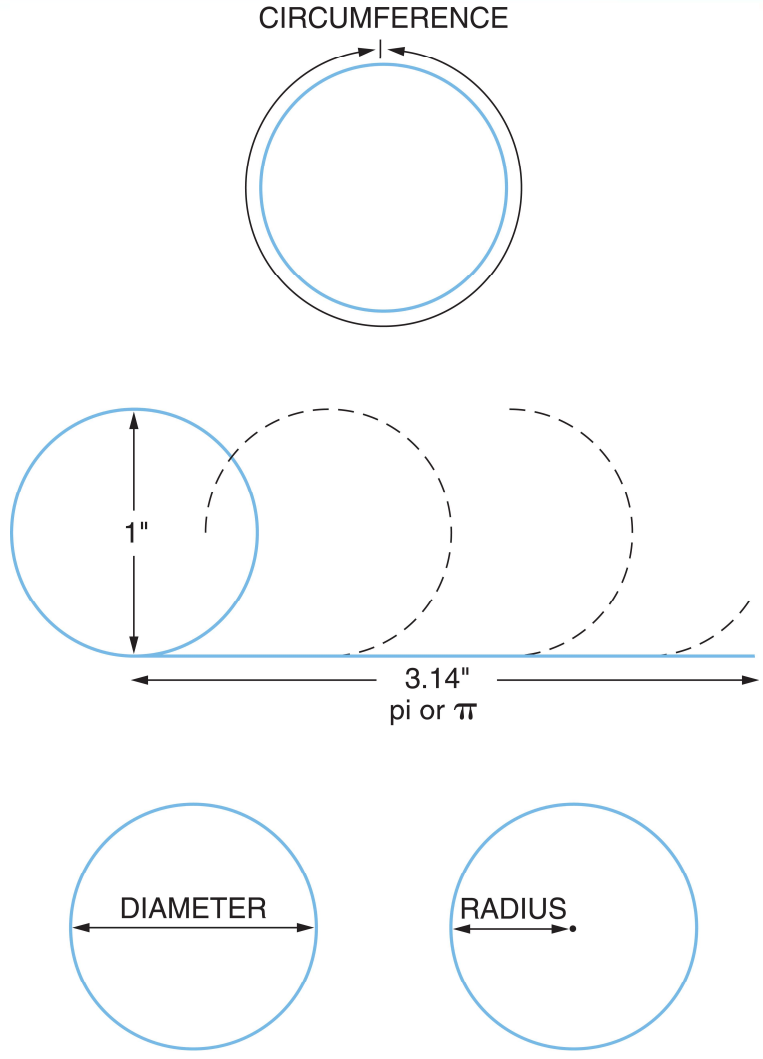


SCALENE TRIANGLE
108° + 22° + 50° = 180°

00102-15_F28.EPS

Sections 6.2.3 and 6.2.4 – Geometry

These circle characteristics are required in many circle-related calculations.



00102-15_F29.EPS

Section 6.3.0 – Geometry

COMMON AREA UNITS

1 square inch = 1 inch × 1 inch = 1 inch^2

1 square foot = 1 foot × 1 foot = 1 foot^2

1 square yard = 1 yard × 1 yard = 1 yard^2

1 square centimeter = 1 cm × 1 cm = 1 cm^2

1 square meter = 1 m × 1 m = 1 m^2

Section 6.3.0 – Geometry

COMMON AREA FORMULAS

- The area of a rectangle = length × width.
- The area of a square also = length × width.
- The area of a circle = π × radius^2. In this formula, you must use the mathematical constant π (pi), which has an approximate value of 3.14. You multiply π times the radius of the circle squared (multiplied times itself).
- The area of a triangle = 1⁄2 × base × height.

Section 6.3.1 – Geometry

1. The area of a rectangle that is 8 feet long and 4 feet wide is _____.
   a. 12 sq ft
   b. 22 sq ft
   c. 32 sq ft
   d. 36 sq ft

2. The area of a 16cm square is _____.
   a. 256 sq cm
   b. 265 sq cm
   c. 276 sq cm
   d. 278 sq cm

Section 6.3.1 – Geometry

3. The area of a circle with a 14-foot diameter is _____.
   a. 15.44 sq ft
   b. 43.96 sq ft
   c. 153.86 sq ft
   d. 196 sq ft

Sections 6.4.0 and 6.4.1 – Geometry

COMMON VOLUME FORMULAS

1 cubic inch = 1 inch × 1 inch × 1 inch = 1 $inch^3$

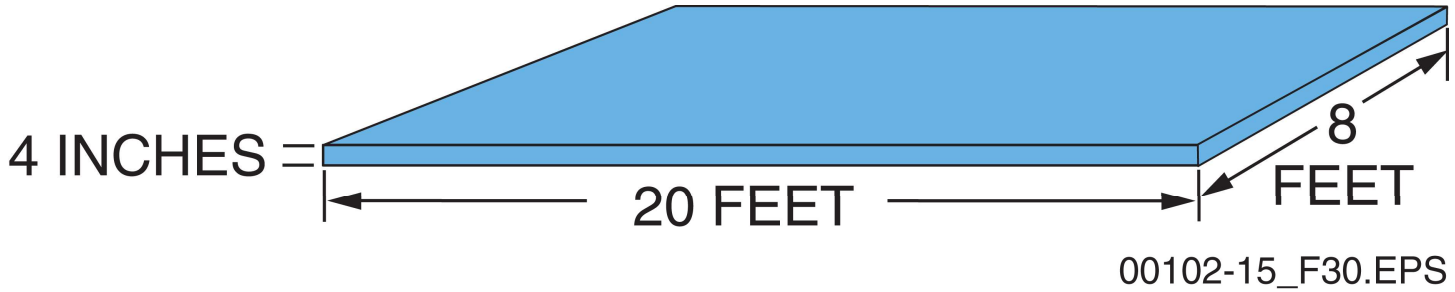
1 cubic foot = 1 foot × 1 foot × 1 foot = 1 $foot^3$

1 cubic yard = 1 yard × 1 yard × 1 yard = 1 $yard^3$

1 cubic centimeter = 1 centimeter × 1 centimeter × 1 centimeter = 1 cm^3

1 cubic meter = 1 meter × 1 meter × 1 meter = 1 m^3

Sections 6.4.0 and 6.4.1 – Geometry



VOLUME OF A SLAB

Step 1 Convert inches to feet.

4 in ÷ 12 = 0.33 ft

Step 2 Multiply length × width × depth.

20 ft × 8 ft × 0.33 ft = 52.8 cu ft

Step 3 Convert cubic feet to cubic yards.

52.8 cu ft ÷ 27 (cu ft per cu yd) = 1.96 cu yd of concrete

Sections 6.4.3 and 6.4.4 – Geometry

VOLUME OF A CYLINDER

$\pi \times \text{radius}^2 \times \text{height}$ (or **$\pi r^2 \times \text{height}$**)

Step 1 First, calculate the area of the circle using πr^2. Since the diameter is 22 feet, the radius will be 11 feet (half the diameter).

Area of the circle = $3.14 \times 11^2 = 379.94$ sq ft

Step 2 Then calculate the volume (area × height).

379.94 sq ft × 10 ft = 3,799.4 cu ft

Sections 6.4.3 and 6.4.4 – Geometry

VOLUME OF A TRIANGULAR PRISM

0.5 × base × height × depth (thickness)

Step 1 Calculate the area of the flat triangle first:

0.5 × 6 × 12 = 36 sq cm area

Step 2 Then calculate the volume of the prism, by adding the factor of depth:

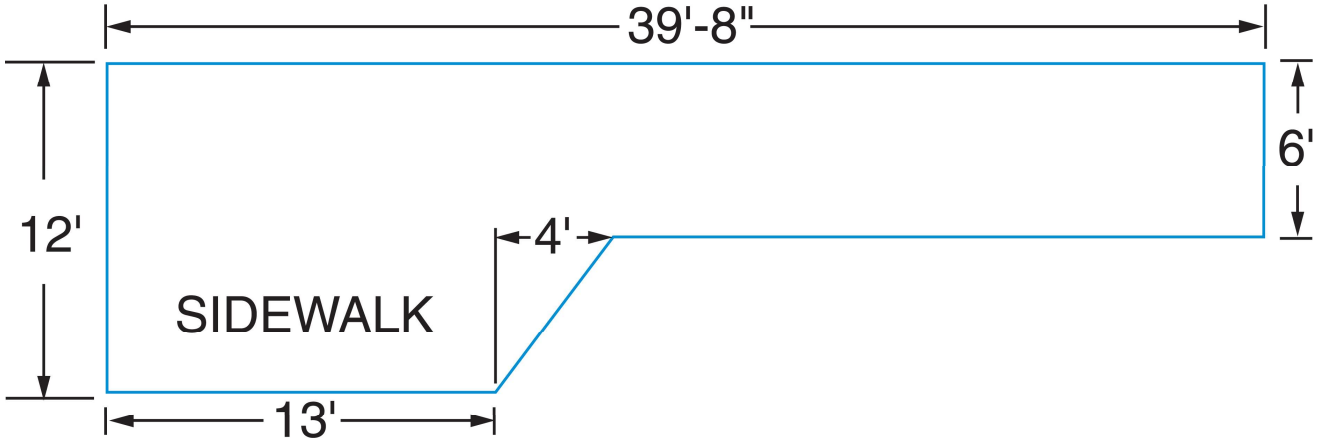
36 sq cm × 11 cm = 396 cu cm

Sections 6.4.5 and 6.4.6 – Geometry

2. The volume of a 3 cm cube is _____.
   a. 6 cu cm
   b. 9 cu cm
   c. 12 cu cm
   d. 27 cu cm

3. The volume of a triangular prism that has a 6-inch base, a 2-inch height, and a 4-inch depth is _____.
   a. 12 sq in
   b. 24 cu in
   c. 36 cu in
   d. 48 sq in

Sections 6.4.5 and 6.4.6 – Geometry



00102-15_F35.EPS

2. To pour the concrete sidewalk shown in the figure, approximately how many cubic feet of topsoil will you need to remove for the 4" thick sidewalk if the owner wants the finish surface of the sidewalk to be level with the adjacent topsoil? Round your answer to the nearest cubic foot.

109 cu ft

Next Session…

MODULE EXAM

Review the complete module to prepare for the exam. Complete the Module Review and Trade Terms Quiz as homework.