Department of Instruction

Engineer Basic Officer's Course

EBOLC Basic Math Workbook

Basic Math Concepts Workbook Contents

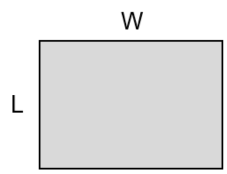
1. Definitions of Concepts

a. Area and Volume Calculations

i. Area (A) of a Square or Rectangle

A = Length (L) x Width (W)

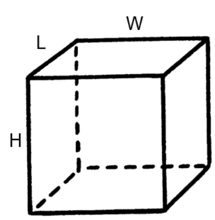
**Note*: Use the same equation to find the area of a square or rectangle.



Units = Square inches (sq in or in^2), square feet (sq ft or ft^2), etc.

ii. Volume (V) of a Cube

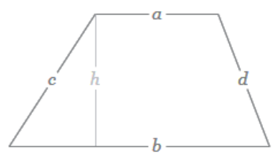
V = Length (L) x Width (W) x Height (H)



Units = Cubic inches (cu in or in^3), cubic feet (cu ft or ft^3), etc…

iii. Area (A) of a Trapezoid

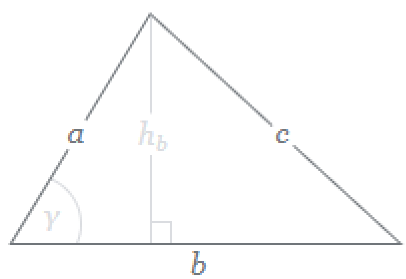
$A = \frac{a+b}{2}h$ where a = top base, b = bottom base, and h = height



Units = Square inches (sq in or in^2), square feet (sq ft or ft^2), etc…

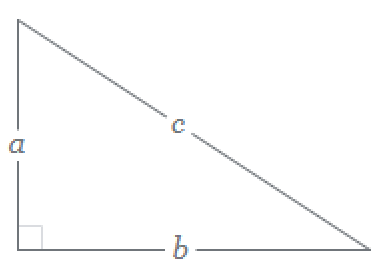
iv. Area (A) of a Triangle

$A = \frac{h_b b}{2}$ where h_b is the height and b is the base of the triangle



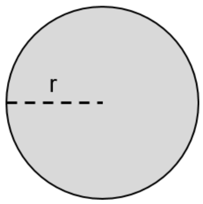
Units = Square inches (sq in or in^2), square feet (sq ft or ft^2), etc…

For a Right Triangle, the Pythagorean Theorem is used: $a^2+b^2=c^2$



v. Area (A) of a Circle

$A = \pi \times \text{Radius}^2 = \pi r^2$, where $\pi = 3.14$



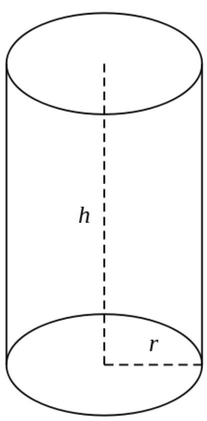
Units = Square inches (sq in or in^2), square feet (sq ft or ft^2), etc…

v. Circumference (C) of a Circle (Perimeter)

$C = 2 \times \pi \times \text{Radius} = 2 \pi r$, where $\pi = 3.14$

vi. Volume (V) of a Cylinder

$V = A \times H = (\pi \times r^2) \times h = \pi r^2 h$



Units = Cubic Inches (cu in or in^3), cubic feet (cu ft or ft^3)

b. Conversions

i. Area

12 in = 1 ft

1 ft^2 or (1ft x 1ft) = 144 in^2 or (12 in x 12 in)

To convert from ft^2 to in^2 → ft^2 x $\frac{144\ in2}{1\ ft^2}$ = in^2

Example: 2 ft^2 x 144 in^2 = 288 in^2

To convert in^2 to ft^2 → in^2 / 144 in^2/ft^2

Example: 288 in^2 / 144 in^2/ft^2 = 2 ft^2

ii. Volume

12 in = 1 ft

1 cu ft or (1 ft x 1 ft x 1 ft) = 1728 in^3 or (12 in x 12 in x 12 in)

1 cu yd or (1 yd x 1 yd x 1 yd) = 27 cu ft or (3 ft x 3 ft x 3ft)

Convert from ft^3 to in^3 → ft^3 x 1728 in^3 / ft^3

Example: 2 ft^3 x 1728 in^3 / ft^3 = 3456 in^3

Convert from in^3 to ft^3 → in^3 / 1728 in^3 / ft^3

Example: 3456 in^3 / 1728 in^3 / ft^3 = 2 ft^3

iii. Common Unit Conversions

Converting Standard Units between standard, area, and volume

When converting units, table 1 (Appendix A) is used to standard two-dimensional quantities. For example, 12 inches in length is equal to 1 foot in length. When you are tasked to convert square inches into square feet, the conversion table can still be utilized but the conversion factors need to be adjusted. To do this, simply use the exponent of the measurement (area = a^2, volume = a^3). For example, to convert cu in into cu ft, you would take 12in and cube the value. $(12 \text{ in})^3 = 1{,}728 \text{ in}^3$, therefore $1{,}728 \text{ in}^3 = 1 \text{ ft}^3$.

**Note: See Appendix A-1 for Unit Conversion Chart.*

c. Dimensional Analysis

Dimensional Analysis (or unit cancellation) is a tool that can assist in situations involving a mix of different kinds of quantities. It is used routinely by engineers to check if equations are correct and units match. Only like dimensioned quantities may be added, subtracted, compared, or equated: “apples to apples” NOT “apples to oranges”.

For example, when converting cubic feet (cu ft) to cubic yards (cu yds) you divide cu ft by cu ft per cu yds:

$$\frac{\cancel{\text{cu. ft}}}{1} \times \left(\frac{\text{cu. yds}}{\cancel{\text{cu. ft}}}\right) = \text{cu. yds}$$

The cu. ft values cancel out and leave the desired result of cu. yds.

Dimensional analysis can be used to determine how conversion factors are derived, and whether your equation is set up properly (if you divide when you should multiply, your units will be incorrect).

Example Problem for Dimensional Analysis:

Change a speed of 72.4 miles per hour (mph) to meters per second (mps)

$$\frac{72.4\ \cancel{mi}}{1\ \cancel{hr}} \times \frac{1760\ \cancel{yd}}{1\ \cancel{mi}} \times \frac{36\ \cancel{in}}{1\ \cancel{yd}} \times \frac{0.02540\ \mathbf{m}}{1\ \cancel{in}} \times \frac{1\ \cancel{hr}}{3600\ \mathbf{sec}} = 32.37\ \text{mps}$$

Alternatively, you can use the conversion factor 1,609.34 meters in 1 mile:

$$\frac{72.4\ \cancel{mi}}{1\ \cancel{hr}} \text{x} \frac{1{,}609.34\ \text{m}}{1\ \cancel{mi}} \text{x} \frac{1\ \cancel{hr}}{3{,}600\ \text{sec}} = 32.37\ \text{mps}$$

d. <u>Speed, Time, and Distance Equations</u>

When dealing with problems involving speed, time, and distance relationships, an easy tip to remember to solve for the unknown value is the speed, time, and distance triangle.

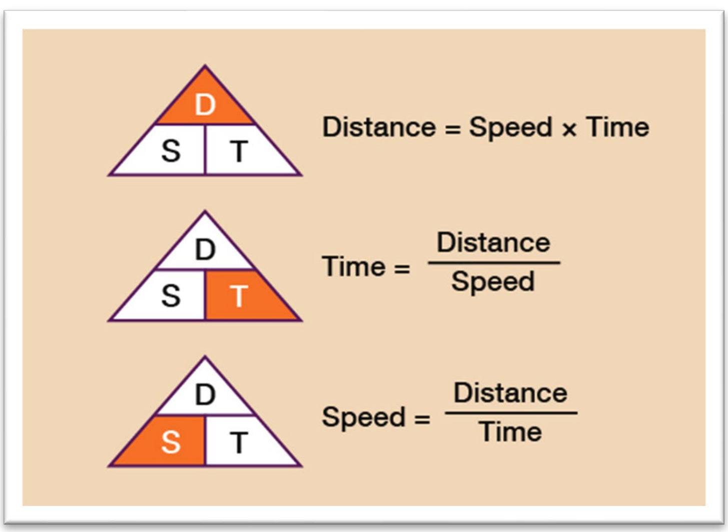


Figure 1: Distance, Speed and Time[1]

Example: How long will it take for a car traveling 65 mph to travel 57 miles?

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{57\ \text{miles}}{65\ \text{mph}} = 0.88\ \text{hours x} \frac{60\ \text{min}}{1\ \text{hour}} = \mathbf{52.8\ minutes}$$

Example: A train is travelling at a speed of 125 mph for a span of 18 hours non-stop, how far the train will have travelled?

Distance = Speed x Time = $\frac{125\ miles}{\cancel{hour}}$ x 18 ~~hours~~ = **2,250 miles** travelled

e. <u>Percentage Slope</u>

Percentage slope is determined by dividing the amount of elevation change by the amount of horizontal distance covered (otherwise referred to as, "rise over run,") and then multiplying the result by 100 percent.

Example: A pipe rises 2 feet in a run of 100 feet:

Percentage slope of the pipe = $\left(\frac{2ft}{100ft}\right)$ = .02 x100 = 2% slope.

Note: You must always multiply by 100 when calculating the percent slope of an object. Otherwise, you will simply be reporting the value of the numerator divided by the denominator. In our example above, $\frac{2ft}{100ft}$=0.02. Stated another way, if you use the word "percent" following a calculated number, you must first have multiplied that number by 100.

f. <u>Rounding</u>

i. Place Value and Decimals

A decimal number is based on the number "10" and contains a decimal point. The place value, or position of each digit, is important when dealing with decimals. Using the example of 307:

The "3" is in the "Hundreds" position, meaning 3 hundreds (or 300)

The "0" is in the "Tens" position, meaning 0 tens (or 0)

The "7" is in the ones position, meaning 7 ones (or seven)

Together, the numbers create “307.” When dealing with place values we use “the rule of tens.” As you move left each place value is 10 times larger than the last. Vice versa, as you move right each place value is 10 times smaller than the last.

As you move past the decimal point, the place values continue to follow the rule of 10. Each place simply becomes 10 times smaller than the last.

Example: 5.467 place values explained.

The “5” is in the ones position, meaning 5 ones (of 5)

The “4” is in the tenths (1/10) position, meaning 4 tenths (or 4/10)

The “6” is in the hundredths (1/100) position, meaning 6 hundredths (or 6/100)

The “7” is in the thousandths (1/1000) position, meaning 7 thousandths (or 7/1000)

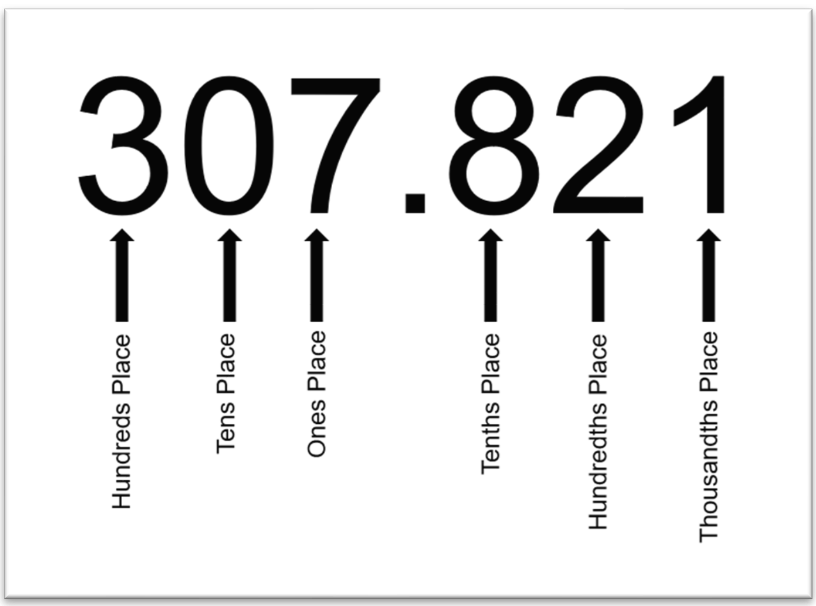


Figure 2: Place Value Labels

**Note: When dealing with decimals, all digits to the left of the decimal place refer to “whole” numbers, and all digits to the right of the decimal place refer to fractions of a whole number.*

Understanding the place values of numbers is important when you begin rounding numbers. You may be expected to round numbers to the tenths, hundredths, or thousandths place when dealing with math problems. Knowing what number placement these instructions refer to will aide you in finding the right answers to your problem sets.

ii. Normal Rounding Rule

Under normal rounding rules, a number less than 5, $x < 5$, is rounded down to 0, and a number greater than or equal to 5, $5 \le x < 5$, is rounded up to 10.

Example: 12.4 is rounded to 12

12.5 is rounded to 13

iii. Exception to Rounding Rule

An exception to the normal rounding rule is when you cannot have a part of something and can only have whole amounts (part of a person, part of a trip, part of a product). When this occurs, always round up to the next whole number unless instructed otherwise.

Example: You have calculated 6.2 trips are required to move a load of supplies; you would round this to 7 trips because you cannot have 0.2 trips.

Example: A board length of 12 ft 6 in is required for use as building studs. This length cannot be purchased. 14 ft boards must instead be purchased and cut down to length.

g. Exponents and Square Root Equations

i. Exponents: To square a number is to multiply that number by itself.

Example: $5^2 = 5 \times 5 = 25$

ii. Square Root: To calculate the square root of a number is to find the number which, when multiplied by itself, equals the number encompassed by the square root symbol.

Example: $\sqrt{100}=10$, because $10 \times 10 = 100$. This function can also be expressed by $(100)^{1/2}$ or $10^{0.5}$.

h. Order of Operations

Math's Order of Operations tells you the sequence to follow when you are performing operations in a mathematic equation. **P.E.M.D.A.S**. (otherwise known as the order of operations) is the method used to solve mathematic equations with multiple expressions. The acronym breaks down as such:

P: Parentheses: ( )

E: Exponents/Square root: a^2 ($\sqrt{a}$)

M: Multiply: x

D: Divide: /

A: Add: +

S: Subtract: -

Another way to remember the order of operations is to use the phrase, "Please Excuse My Dear Aunt Sally."

This means that when solving a mathematic equation, you begin your work with and operations contained in parentheses, next solve for any exponents or roots, then continue to multiplication or division, and finish your work with addition or subtraction operations.

Example: when given the equation: 9 – (2 x 3) x 4 + 5^2 = _____? Using PEMDAS:

Begin with the parentheses: (2 x 3) = 6 → 9 – 6 x 4 + 5^2

Continue to the exponents: 5^2 = 25 → 9 – 6 x 4 + 25

Next is multiply or divide: 6 x 4 = 24 → 9 – 24 + 25

Finish with addition or subtraction: -15 + 25 = 10

Therefore, 9 – (2 x 3) x 4 + 5^2 = 10

2. **Practice Problems**

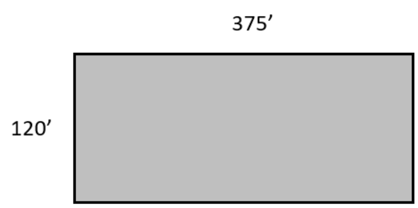
a. <u>Area and Volume Calculations</u>

i. Area (A) of a Square or Rectangle

What is the area of the below rectangle in sq ft? In sq in?

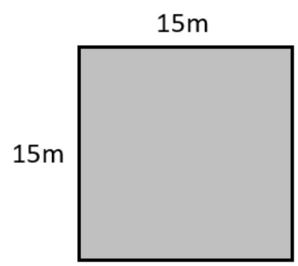
(Round to tenths) sq ft:______ sq in:_____

What is the area of the below rectangle in sq ft? In sq yds?



sq ft: _____ sq yds: ______

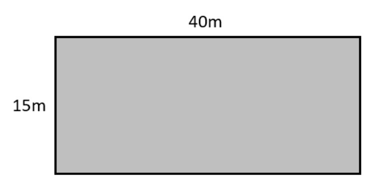
What is the area of the below square in sq m? In sq km?



sq m: ______ sq km: ______

What is the area of the below rectangle in sq m? In sq ft?

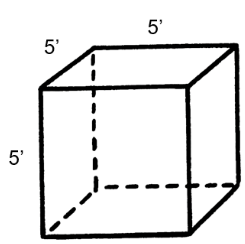
*(1 m = 3.28084 ft and 1 sq m = 10.76391111 sq ft)



sq m: _____ (Round to hundredths) sq ft: _____

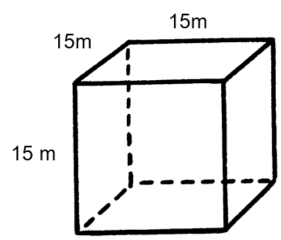
ii. Volume (V) of a Cube

What is the Volume (V) of the below cube in ft^3? In yds^3?



ft^3: _____ (Round to hundredths) yds^3: ______

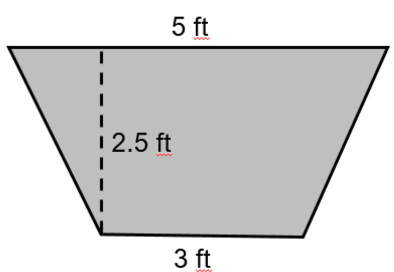
What is the Volume (V) of the below cube in m^3? In ft^3?



m^3: _____ (Round to hundredths) ft^3: _____

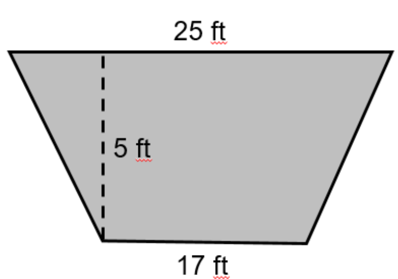
iii. Area (A) of a Trapezoid

What is the Area (A) of the Trapezoid below in sq ft? In sq yds?



sq ft: _____ (Round to hundredths) sq yds: _____

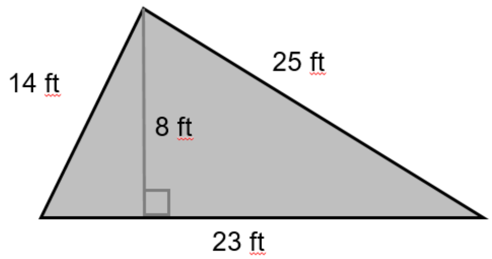
What is the Area (A) of the Trapezoid below in sq ft? In sq m?



sq ft: _____ (Round to hundredths) sq m: _____

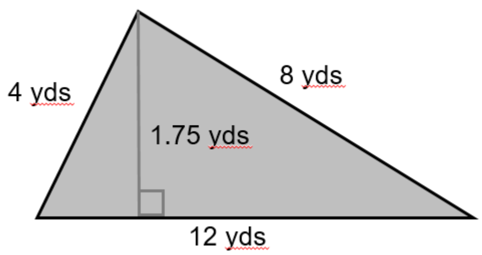
iv. Area (A) of a Triangle

What is the area of the triangle below in ft^2? In yds^2?



ft^2: _____ (Round to hundredths) yds^2: _____

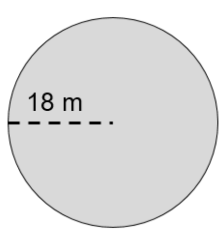
What is the area of the triangle below in yds^2? In in^2?



(Round to tenths) yds^2: _____ in^2: _____

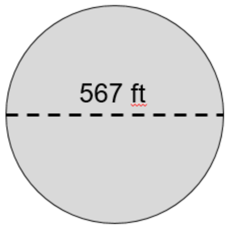
v. Area (A) of a Circle

What is the area of the Circle below in m^2? In yds^2?



(Round to hundredths) m^2: _____ (Round to hundredths) yds^2: _____

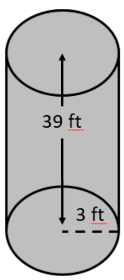
What is the area of the Circle below in ft^2? In km^2?



(Round to hundredths) ft^2: _____ (Round thousandths) km^2: _____

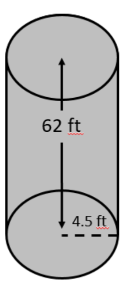
vi. Volume (V) of a Cylinder

What is the volume of the Cylinder below in ft^3? In m^3?



(Round to hundredths) ft^3: _____ (Round to hundredths) m^3: _____

What is the volume of the Cylinder below in m^3? In yds^3?



(Round to hundredths) m^3: _____ (Round to hundredths) yds^3: _____

b. Conversions

i. Area

Convert 350 km^2 into mi^2 (Round to hundredths)

mi^2: __________

Convert 65,000 acres into yds^2

yds^2: __________

Convert 95,650 in^2 into m^2 (Round to hundredths)

m^2: ____________

ii. Volume

Convert 3,428,425,678 in^3 into yds^3 (Round to hundredths)

yds^3: _______________

Convert 567 m^3 into cm^3

cm^3: ________________

Convert 973 km^3 into ft^3

ft^3: __________________

c. Dimensional Analysis

Use dimensional analysis to convert 150 miles into inches.

Inches: _______________

Use dimensional analysis to convert 725 miles into yards.

Yards: ________________

Use dimensional analysis to convert 654 acres into square feet.

Square Feet: _________________

Use dimensional analysis to convert 13.5 days into minutes.

Minutes: ________________

d. Speed, Time, and Distance Equations

Calculate the time required, in hours and minutes, for a vehicle driving at 45 mph to travel a distance of 2500 miles.

Hours: ___________________

How far can a HMMWV travel if it drives 65 kph for 6 hours and 15 minutes?

(Round to hundredths) Kilometers: _________________

How fast would a train need to travel if it can span 1,200 miles in 9 hours?

(Round to hundredths) mph: ________________

What is the distance traveled if a vehicle moving 70 mph travels at that rate for 16 hours?

Miles: ____________________

e. <u>Percentage Slope</u>

Calculate the percentage slope for the following slopes:

Rise = 50ft Run = 15ft

(Round to hundredths) % Slope = _____

Rise = 125cm Run = 25m

% Slope = _____

Rise = 40yds Run = 75yds

(Round to hundredths) % Slope = _____

Rise = 6in Run = 15ft

(Round to hundredths) % Slope = _____

f. Rounding

i. Normal Rounding Rules

Round the following numbers using the normal rounding rules.

17.56 to the tenths → ___

2476 to the tens → ___

15,093.1 to the ones → ___

1.768 to the hundredths → ___

19.8 to the ones → ___

1,604 to the tens → ___

ii. Exception Rounding Rules

Round the following numbers using the exception rounding rules.

Calculated 15.9 trips needed→ ___ trips to complete

Calculated 16.1 boxes of nails needed → ___boxes to order

Calculated 467 bricks needed, bricks are sold by tens → ___ bricks to order

Calculated 591 tiles, tiles are sold by hundreds → ___ tiles to order

Calculated 7,984 sheets, paper is sold by hundreds→ ___ sheets to order

Calculated 16,142 feet needed, sold in 10 ft lengths → ___ feet to order

g. Exponents and Square Root Equations

i. Exponents

1^2 = ___

14^2 = ___

4^{15} = ___

5^3 = ___

ii. Square Root

$\sqrt{16} =$ ___

$\sqrt{52} =$ ___(Round to hundredths)

$\sqrt{1{,}452} =$ ___(Round to hundredths)

$\sqrt{67{,}432} =$ ___(Round to hundredths)

h. Order of Operations

$5 \times (4 + 3^2)^2 - 16 =$ ______

$2 + 3 \times 4 / (3^2 + 6) - 4 =$ ______

$2 / 4 + (15 - 4^2)^2 =$ ______

$50 - 23^2 + 100 \times (54 - 10^2) / 3 =$ ______

3. Answer Key

a. Area and Volume Calculations

i. Area (A) of a Square or Rectangle

Sq ft: 12.5 sq ft   Sq in: 1,800 sq in

5ft x 2.5ft = 12.5 sq ft

12.5 sq ft x (144 sq in / 1 sq ft) = 1,800 sq in

Sq ft: 45,000 sq ft   Sq yds: 5,000 sq yds

120 ft x 375 ft = 45,000 sq ft

45,000 sq ft x (1 sq yd / 9 sq ft) = 5,000 sq yds

Sq m: 225 sq m   Sq km: 0.000225 sq km or 2.25×10^{-4} sq km

15 m x 15 m = 225 sq m

225 sq m x (1 sq km / 1,000,000 sq m) = 0.000225 sq km

Sq m: 600 sq m   Sq ft: 6,458.35 sq ft

15 m x 40 m = 600 sq m

600 sq m x (10.76391111 sq ft / 1 sq m) = 6,458.35 sq ft

ii. Volume (V) of a Cube

ft^3: 125 ft^3 yds^3: 4.63 yds^3

5 ft x 5 ft x 5 ft = 125 ft^3

125 ft^3 x (1 yds^3 / 27 ft^3) = 4.63 yds^3

m^3: 3,375 m^3 ft^3: 119,186.99 ft^3

15 m x 15 m x 15 m = 3,375 m^3

3,375 m^3 x (1 ft^3 / 0.02831685 m^3) = 119,186.99 ft^3

iii. Area (A) of a Trapezoid

ft^2: $\underline{10\ ft^2}$ yds^2: $\underline{1.11\ yds^2}$

$A = [(3ft + 5ft) / 2] \times 2.5\ ft = 10\ ft^2$

$10\ ft^2 \times (1\ yd^2 / 9\ ft^2) = 1.11\ yd^2$

ft^2: $\underline{105\ ft^2}$ m^2: $\underline{9.75\ m^2}$

$[(25ft + 17ft) / 2] \times 5\ ft = 105\ ft^2$

$105\ ft^2 \times (0.09290304\ m^2 / 1\ ft^2) = 9.75\ m^2$

iv. Area (A) of a Triangle

ft^2: $\underline{92\ ft^2}$ yds^2: $\underline{10.22\ yds^2}$

$A = (8\ ft \times 23\ ft) / 2 = 92\ ft^2$

$92\ ft^2\ (1\ yds^2 / 9\ ft^2) = 10.22\ yds^2$

yds^2: $\underline{10.5\ yds^2}$ in^2: $\underline{13{,}608\ in^2}$

$A = (1.75\ yd \times 12\ yds) / 2 = 10.5\ yds^2$

$10.5\ yds^2 \times (9ft^2 / 1\ yds^2) \times (144\ in^2 / 1\ ft^2) = 13{,}608\ in^2$

v. Area (A) of a Circle

m^2: $\underline{1{,}017.36\ m^2}$ yds^2: $\underline{1{,}216.75\ yds^2}$

$A = 3.14 \times (18m)^2 = 1{,}017.36\ m^2$

$1{,}017.36\ m^2 \times (1\ yds^2 / 0.8361274\ m^2) = 1216.75\ yds^2$

ft^2: $\underline{252{,}368.87\ ft^2}$ km^2: $\underline{0.023\ km^2}$

$A = 3.14 \times (283.5)^2 = 252368.87\ ft^2$

$252{,}368.87\ ft^2\ (0.09290304\ m^2 / 1\ ft^2)\ (1\ km^2 / 1{,}000{,}000\ m^2) = 0.023\ km^2$

vi. Volume (V) of a Cylinder

ft^3: $\underline{1102.14\ ft^3}$ m^3: $\underline{31.21\ m^3}$

$V = (3.14 \times 9ft^2) \times 39\ ft = 1{,}102.14\ ft^3$

$1{,}102.14\ ft^3 \times (0.02831685\ m^3 / 1\ ft^3) = 31.21\ m^3$

m^3: $\underline{111.63\ m^3}$ yds^3: $\underline{146.01\ yds^3}$

$V = (20.25\ ft^2 \times 3.14) \times 62\ ft = 3942.27\ ft^3$

$3{,}942.27\ ft^3 \times (0.02831685\ m^3 / 1\ ft^3) = 111.63\ m^3$

$3{,}942.27\ ft^3 \times (1\ yds^3 / 27\ ft^3) = 146.01\ yds^3$

b. Conversions

i. Area

mi^2: 135.14 mi^2

350 km^2 x (1 mi^2 / 2.589988 km^2) = 135.14 mi^2

yds^2: 314,600,000 yds^2 or 3.146 x 10^8 yds^2

65,000 acres x (43,560 ft^2 / 1 acre) x (1 yd^2 / 9 ft^2) =

314,600,000 yds^2 or 3.146 x 10^8 yds^2

m^2: 61.71 m^2

95,650 in^2 x (645.16 mm^2 / 1 in^2) x (1 m^2 / 1000000 mm^2) = 61.71 m^2

ii. Volume

yds^3: 73,483.06 yds^3

3,428,425,678 in^3 x (1ft^3/1,728in^3) x (1 yds^3/27ft^3) = 73,483.06 yds^3

cm^3: 567,000,000 cm^3 or 5.67 x 10^8 cm^3

567 m^3 x (1,000,000 cm^3/1m^3) = 567,000,000 cm^3

ft^3: 34,400,000,000,000 ft^3 or 3.44 x 10^{13} ft^3

973 km^3 x (1 mi / 1.60934 km)^3 x (5280 ft / 1 mi)^3 = 34,316,458,730,000 ft^3 or 3.43 x 10^{13} ft^3

c. Dimensional Analysis

150 miles → ___ inches

150 miles x (5,280 ft / 1 mile) x (12 in / 1 ft) = 9,504,000 in or 9.504 x 10^6 in

725 miles → ___ yards

725 miles x (1760 yds / 1 mi) = 1,276,000 yds or 1.276 x 10^6 yds

654 acres → ___ square feet

654 acres x (43,560 sq ft / 1 acre) = 28,488,240 sq ft or 2.85 x 10^7 sq ft

13.5 days → ___ minutes

13.5 days x (24hrs / 1 day) x (60 min / 1 hr) = 19,440 min or 1.94 x 10^4 min

d. Speed, Time, and Distance

Calculate the time required, in hours and minutes, for a vehicle driving at 45 mph to travel a distance of 2500 miles.

Time = $\frac{Distance}{Speed}$ **=** $\frac{2500\ miles}{45\ mph}$ **= 55.55 Hours**

0.55 hours x 60 minutes = 33 minutes

Time = 55 Hours and 33 Minutes

How far can a HMMWV travel if it drives 65 kph for 6 hours and 15 minutes?

Distance = Speed x Time = 65 kph x 6.25 Hours = 406.25 km

How fast would a train need to travel if it can span 1,200 miles in 9 hours?

Speed = $\frac{Distance}{Time}$ **= 1,200 miles / 9hours = 133.33 mph**

What is the distance traveled if a vehicle moving 70 mph travels at that rate for 16 hours?

Distance = Speed x Time = 70 mph x 16 hours = 1,120 miles

e. Percentage Slope

Rise = 50ft   Run = 15ft

% Slope = $\frac{50ft}{15ft}$**x100% = 333.33% Slope**

Rise = 125cm   Run = 25m

% Slope = $\frac{[125cm\left(\frac{1m}{100cm}\right)]}{25m}$**x100% = 5% Slope**

Rise = 40yds   Run = 75yds

% Slope = $\frac{40\ yds}{75\ yds}$**x100% = 53.33% Slope**

Rise = 6in   Run = 15ft

% Slope = $\frac{[6in\left(\frac{1ft}{12in}\right)]}{15ft}$**x100% = 3.33% Slope**

f. <u>Rounding Rules</u>

i. Normal Rounding Rules

Round the following numbers using the normal rounding rules.

17.56 → **<u>17.6</u>**

2,476 → **<u>2480</u>**

15,093.1 → **<u>15,093</u>**

1.768 → **<u>1.77</u>**

19.8 → **<u>20</u>**

1,604 → **<u>1,600</u>**

ii. Exception Rounding Rules

Round the following numbers using the exception rounding rules.

15.9 → **<u>16</u>**

16.1→ **<u>17</u>**

467 → **<u>470</u>**

591 → **<u>600</u>**

7,984 → **<u>8,000</u>**

16,142 → **<u>16,150</u>**

g. Exponents and Square Root Equations

i. Squaring

1^2 = 1 x 1 = 1

14^2 = 14 x 14 = 196

4^{15} = 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 = 1.074 x 10^9 or

1,073,741,824

5^3 = 5 x 5 x 5 = 125

ii. Square Root

$\sqrt{16} = 16^{1/2}$ = 4

$\sqrt{52} = 52^{1/2}$ = 7.21

$\sqrt{1{,}452} = 1{,}452^{1/2}$ = 38.11

$\sqrt{67{,}432} = 67{,}432^{1/2}$ = 259.68

h. Order of Operations

5 x $(4 + 3^2)^2$ – 16 = ______

5 x $(4 + 9)^2$ – 16 =
5 x $(13)^2$ – 16 =
5 x 169 – 16 =
845 – 16 = 829

2 + 3 x 4 / (3^2 +6) – 4 = ______

2 + 3 x 4 / (9 + 6) – 4 =
2 + 3 x 4 / 15 – 4 =
2 + 12 / 15 – 4 =
2 + 0.8 – 4 = -1.2

2 / 4 + $(15 – 4^2)^2$ = ______

2 / 4 + $(15 – 16)^2$ =
2 / 4 + $(-1)^2$ =
2 / 4 + 1 =
0.5 + 1 = 1.5

50 – 23^2 +100 x (54 – 10^2) / 3 = ______

50 – 23^2 + 100 x (54 – 100) / 3 =

$50 – 23^2 + 100 \times (-46) / 3 =$
50 – 529 + 100 x (-46) / 3 =
50 – 529 + (-4600) / 3 =
50 – 529 + (-1533.33) = <u>-2012.33</u>

Appendix A: Conversion Chart

Table A-1: Unit Conversion Chart		
Starting Units	**Desired Units**	**Conversion Factor or Equation**
Inches (in)	Milimeters (mm)	1 in = 25.40 mm
Inches (in)	Centimeters (cm)	1 in = 2.54 cm
Inches (in)	Meters (m)	1 in = 0.02540 m
Feet (ft)	Inches (in)	1 ft = 12 in
Feet (ft)	Meters (m)	1 ft = 0.3048 m
Yards (yds)	Inches (in)	1 yd = 36 in
Yards (yds)	Feet (ft)	1 yd = 3 ft
Yards (yds)	Meters (m)	1 yd = 0.91440 m
Miles (mi)	Kilometers (km)	1 mi = 1.60934 km
Miles (mi)	Feet (ft)	1 mi = 5,280 ft
Miles (mi)	Yards (yds)	1 mi = 1,760 yds
Acres	Square Feet (sq. ft)	1 acre = 43,560 sq. ft
Acres	Square Meters (sq. m)	1 acre = 4,046.9 sq. m
Acres	Hectares (ha)	1 acre = 0.40469 ha
Milimeters (mm)	Centimeters (cm)	10 mm = 1 cm
Centimeters (cm)	Meters (m)	100 cm = 1 m
Meters (m)	Kilometers (km)	1,000 m = 1 km
Square Inches (sq. in)	Square Milimeters (sq. mm)	1 sq. in = 645.16 sq. mm
Square Inches (sq. in)	Square Centimeters (sq. cm)	1 sq. in = 6.4516 sq. cm
Square Feet (sq. ft)	Square Meters (sq. m)	1 sq. ft = 0.09290304 sq. m
Square Yards (sq. yds)	Square Meters (sq. m)	1 sq. yd = 0.8361274 sq. m
Square Miles (sq. mi)	Square Kilometers (sq. km)	1 sq. mi = 2.589988 sq. km
Cubic Feet (cu. ft)	Cubic Meters (cu. m)	1 cu. ft = 0.02831685 cu. m
Cubic Yards (cu. yds)	Cubic Meters (cu. m)	1 cu. yd = 0.764555 cu. m
Board Feet	Cubic Meters (cu. m)	1 board foot = 2.831685 cu. m
Acre-Foot	Cubic Meters (cu. m)	1 acre-foot = 1,233.5 cu. m
Gallon (gal)	Liter (L)	1 gal = 3.785412 L
Feet Per Second (fps)	Meters Per Second (mps)	1 fps = 0.3048 mps
Miles Per Hour (mph)	Kilometers Per Hour (kph)	1 mph = 1.6093 kph
Miles Per Gallon (mpg)	Kilometers Per Liter (kpl)	1 mpg = 0.4251437 kpl
Tons (long)	Kilograms (kg)	1 ton (long) = 1,016.047 kg
Tons (long)	Metric Tons	1 ton (long) = 1.016047 metric tons
Metric Tons	Kilograms (kg)	1 Metric Ton = 1,000 kg
Ton (short)	Kilograms (kg)	1 ton (short) = 907.18474 kg
Ton (short)	Metric Tons	1 ton (short) = 0.9071847 kg
Pounds (lbs)	Kilograms (kg)	1 lb = 0.45360 kg
Tons	Metric Tons	1 ton = 0.90720 metric tons
Fahrenheit (t_F)	Celcius (t_C)	$t_C = \frac{(t_F - 32)}{1.8}$
Celcius (t_C)	Fahrenheit (t_F)	$t_F = 1.8\ t_C + 32$

Table 1: Metric Conversion Chart (ATP 3-34.40, Appendix A-1)[2], Conversion Factors (Federal Standard 376B)[3]

References

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2. Department of Defense, Department of the Army. (2015, February). *General Engineering* (Army Techniques Publications No. 3-34.40; Publication No. ATP 3-34.40). Department of the Army.

3. US Federal Government General Services Administration. (1993, May 5). *Preferred Metric Units from General Use by the Federal Government* (Federal Standard 376B). General Services Administration