LIFEPAC®

Consumer Math

Student Book

Unit 5

Alpha Omega Publications®

CONSUMER MATHEMATICS 5
CONSTRUCTION AND BUILDING TRADES

CONTENTS

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CONSTRUCTION AND BUILDING TRADES

The construction and building trades constitute a very important component of this nation's economic sector. For anyone seeking a job in any of a number of trades, the ability to handle basic mathematics, including the use of the metric system, is an important asset. Also, since so much of the material specifications used in construction and repair work are in tabular form, an understanding of their application is essential to estimating, ordering, and purchasing the required materials for whatever job one may have.

Practical examples are included in this LIFEPAC that will assist the student in perfecting those mathematical skills relevant to the construction and building trades. The branch of mathematics most appropriate is that dealing with finding lengths, areas, and volumes, known as *mensuration*. This LIFEPAC will enable you to acquire and perfect mensuration skills and will demonstrate some simple yet important applications.

OBJECTIVES

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC.

When you have finished this LIFEPAC, you should be able

1. To identify basic units of the metric system,
2. To use metric prefixes based upon powers of ten,
3. To convert English units to the metric system,
4. To identify plane geometric figures,
5. To compute the areas of geometric figures,
6. To estimate building materials requirements,
7. To identify solid geometric figures,
8. To compute volumes of liquids and solids given appropriate dimensions, and
9. To estimate building materials requirements based on volume.

Survey the LIFEPAC. Ask yourself some questions about this study. Write your questions here.

_____

_____

_____

I. MEASUREMENT SYSTEMS

OBJECTIVES

1. To identify basic units of the metric system.
2. To use metric prefixes based upon powers of ten.
3. To convert English units to the metric system.

Measurements are essential for satisfactory completion of practically all tasks associated with the construction and building trades. Understanding the terms associated with the various measurements is an important element of job performance. Ability to work in either the United States (nonmetric) or the international (metric) systems is necessary because you will find measurements employing both systems in use today. The nonmetric system used in the United States today is called the English system, because it was derived from ancient English measurements. Today, however, England uses the metric system.

METRIC SYSTEM

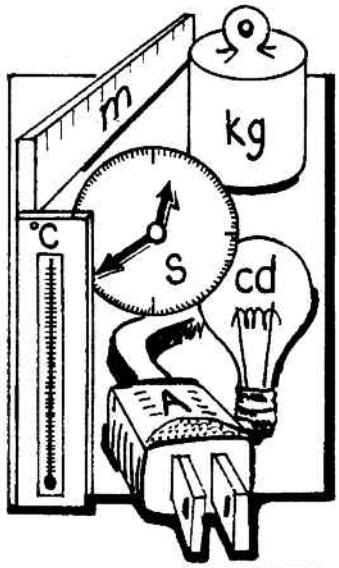
The modern metric system is known as the *International System of Units*. The name *International System of Units* with the international abbreviation (SI) was given to the system by the General Conference on Weights and Measures in 1960.

DEFINITION

The *International System of Units* is a decimal system, based on the number ten, of weights and measures, employing grams, meters, liters, and other units.

Seven Basic units have been established as the *International System of Units*:

The meter (m) for length;
The kilogram (kg) for mass;
The second (s) for time;
The Kelvin (K) or Celsius (C) degree for temperature;
The mole (mol) for the amount of a substance;
The ampere (A) for electric current; and
The candela (cd) for luminous intensity.



These units are the standard, and all other units may be obtained from them by derivation. If we wish to show multiples of these basic units, we simply attach a prefix to the original name to indicate whether we are multiplying or dividing the basic unit and by how much. If the prefix (mega-) ends in the same letter that the basic unit (ampere) begins in, we separate the words with a hyphen: mega-ampere.

PROCEDURE

Metric prefixes are derived from the Greek language and are assigned to a basic unit according to a particular power of 10.

Symbol	Prefix		Prefix	Symbol
G	giga-	10^{9}	nano-	n
M	mega-	10^{6}	micro-	μ
k	kilo-	10^{3}	milli-	m
h	hecto-	10^{2}	centi-	c
dk	deca-	10^{1}	deci-	d

Powers of Ten

Model 1: Express $\frac{1}{1,000}$ gram using the appropriate prefix.

From the Powers of Ten prefix table, we find *milli-* corresponding to 10^{-3}. Therefore, $\frac{1}{1,000}$ gram may be expressed as 1 milligram, or 1 mg.

Model 2: Express 10,000 meters in an equivalent form using the appropriate prefix.

$$10{,}000 = 10^{4} \text{ or } 10 \times 10^{3}$$

From the Powers of Ten prefix table, we find that 10^{3} corresponds to the prefix *kilo-*. Hence, 10×10^{3} meters may be written as 10 kilometers, or 10 km.

Express the following measurements with the appropriate prefixes and symbols.

1.1 $\frac{1}{10}$ meter _____

1.2 100 liters _____

1.3 $\frac{1}{1,000,000}$ gram _____

1.4 1,000 seconds _____

1.5 1,000,000 amperes _____

1.6 10^9 candelas _____

1.7 10,000 grams _____

1.8 $\frac{1}{500,000}$ liter _____

1.9 1 nanosecond _____

1.10 1 hectometer _____

1.11 1 milliampere _____

1.12 1 megaton _____

Once you get used to the metric system, you are going to find it much easier to use in everyday activities. It will ease mathematical problems greatly because of its basis in the decimal system. Just think how much simpler you can make change and figure costs because one cent is $\frac{1}{100}$ of a dollar and a dime is $\frac{1}{10}$ of a dollar; instead of having to convert 120 cents to a dollar, or 3 quarters to a dollar, such as might be the case if our money system were based upon our current system of inches, feet, and yards.

To put this statement to a test, let us consider a rather routine problem of laying a brick patio.

ENGLISH SYSTEM	METRIC SYSTEM
Problem: How many bricks $3\frac{3}{4}$" x 8" will cover a patio 16'3" wide by 19'8" long?	Problem: How many bricks 9.5 cm x 20 cm will cover a patio 5 meters wide by 6 meters long?
Step 1. Convert feet to inches: a. 16 ft. = 16 x 12 = 192 in. b. 19 ft. = 19 x 12 = 228 in.	Step 1. Find the area of the patio: (5 x 100)(6 x 100) = 300,000 cm^2
Step 2. Find total length and width of patio: a. 192 in. + 3 in. = 195 in. b. 228 in. + 8 in. = 236 in.	Step 2. Find the area of each brick: 9.5 x 20 = 190 cm^2
Step 3. Find the area of the patio: 195 x 236 = 46,020 $in.^2$	Step 3. Divide the patio area by the brick area to get the number of bricks needed: 300,000 ÷ 190 = 1,578.9 or 1,579 bricks, rounded off
Step 4. Find the area of each brick: $3\frac{3}{4}$" x 8" = 30 $in.^2$	
Step 5. Divide the patio area by the brick area to get the number of bricks needed: 46,020 ÷ 30 = 1,534 bricks	

The fact that the answers are slightly different is not important--the corresponding measurements used in the United States and metric systems are not exactly equivalent. The important thing is that we took only three steps to arrive at an answer using the metric system in comparison to five steps, and several substeps, in the English system of measurement. In addition, the numbers to work with were much more complex in the English system.

CONVERSION PROCEDURES

Conversion of English units of length to metric units may be accomplished through the application of the following procedure and the use of the conversion table.

PROCEDURE

To convert an English unit of length to the equivalent metric unit of length, multiply the length by the appropriate conversion number. Conversely, to convert a metric unit of length to the equivalent English unit of length, multiply the length by the reciprocal of the appropriate conversion number:

English length x conversion number = metric length.

Metric length x $\frac{1}{\text{conversion number}}$ = English length.

Length Conversion Number Table

English Length	Conversion Number	Metric Length
miles	1.609	kilometers
miles	1,609	meters
yards	9.144×10^{-4}	kilometers
yards	9.144×10^{-1}	meters
feet	3.048×10^{-1}	meters
feet	30.48	centimeters
inches	2.54×10^{-2}	meters
inches	2.54	centimeters
inches	25.4	millimeters

Model 1: How many kilometers in 52 miles?

From the conversion number table, you can find the number of kilometers by multiplying the number of miles given by 1.609. Therefore, 52 x 1.609 = 83.67 kilometers.

Model 2: How many feet in 14 meters?

From the procedure rule given, we know that to convert metric units to English units, we must multiply the metric units given by the reciprocal of the appropriate conversion number found in the table. Since meters = feet x 3.048×10^{-1}, feet = meters x $\frac{1}{0.3048}$ = meters x 3.281. Therefore, 14 x 3.281 = 45.93 feet.

Convert the following unit lengths as indicated.

1.13 Convert $10\frac{1}{2}$ inches to millimeters. _____

1.14 Convert 18 kilometers to miles. _____

1.15 Convert 100 yards to meters. _____

1.16 Convert 600 miles per hour to km per hr. _____

Select the best answer from the series of possible answers provided after each of the following unit length problems.

1.17 To find the number of centimeters in 10 inches, multiply the number of inches given (10) by _____.

a. 3.04 b. 2.54 c. 2.78 d. 2.44

1.18 To find the number of inches in 3.5 meters, multiply the number of meters given (3.5) by _____.

a. 36 b. 25.4 c. 39.4 d. 0.305

1.19 To find the number of miles in 100 kilometers, _____.

a. divide 100 by 1.609
b. multiply 100 by 1.609
c. multiply 100 by 3.281
d. divide 100 by 3.281

Conversion of English units of area to metric units may be accomplished through the application of the following procedure and the use of the conversion table.

PROCEDURE

To convert an English unit of area to the equivalent metric unit of area, multiply the English area by the appropriate conversion number. Conversely, to convert a metric unit of area to its equivalent English unit, multiply the metric area by the reciprocal of the appropriate conversion number:

$$\text{English area} \times \text{conversion number} = \text{metric area.}$$

$$\text{Metric area} \times \frac{1}{\text{conversion number}} = \text{English area.}$$

Area Conversion Number Table

English Area	Conversion Number	Metric Area
square miles	2.59	square kilometers
square miles	259	hectares
acres	4.05×10^{-3}	square kilometers
acres	4.05×10^{-1}	hectares
square yards	8.36×10^{-1}	square meters
square feet	9.29×10^{-2}	square meters
square inches	6.45	square centimeters

Model 1: How many square meters are in a house whose area is 1,750 square feet?

From the procedure rule given, we know that we find the conversion number by which square feet can be converted to square meters and then we multiply the square feet given by this number to obtain the number of square meters. Therefore, $1{,}750 \times 9.29 \times 10^{-2} = 162.58\ m^2$.

Model 2: A piece of cloth measuring 6" by 5" contains 30 $in.^2$ of material. How many square centimeters of material are in this cloth?

square centimeters = square inches x 6.45
Therefore, $30 \times 6.45 = 193.5\ cm^2$.

Convert the following unit areas as indicated.

1.20 Convert 125 square yards to square meters. _____

1.21 Convert $9\frac{1}{2}$ square centimeters to square inches. _____

1.22 Convert 16 square kilometers to acres. _____

1.23 A search plane covers 50 square miles of countryside. How many hectares does the plane search? _____

Write *true* or *false*.

1.24 _____ To convert 5 square meters to square yards, multiply 5 by 1.196.

1.25 _____ To convert 3 square feet to square centimeters, multiply 3 by 9.29×10^{-2}.

1.26 _____ To convert 50 hectares to acres, divide 50 by 4.05×10^{-1}.

1.27 _____ To determine the number of square centimeters in 8 square inches, multiply 8 by 6.45.

English units of volume can be converted to metric units through the application of the following procedure and the use of the conversion table.

PROCEDURE

To convert an English unit of volume to its equivalent metric unit of volume, multiply the English volume by the appropriate conversion number. Conversely, to convert a metric unit of volume to its corresponding English unit, multiply the metric unit given by the reciprocal of the appropriate conversion number:

English unit of volume x conversion number = metric volume.

Metric unit of volume x $\frac{1}{\text{conversion number}}$ = English volume.

Volume Conversion Number Table

English Volume	Conversion Number	Metric Volume
cubic yards	7.645×10^{-1}	cubic meters
cubic feet	2.832×10^{-2}	cubic meters
fluid ounces	29.574	cubic centimeters
pints (liquid)*	473.18	cubic centimeters
quarts (liquid)	946.36	cubic centimeters
pints (liquid)	4.732×10^{-1}	liters
quarts (liquid)	9.463×10^{-1}	liters
gallons (liquid)	3.785	liters

*To find the conversion number for dry equivalent volume, multiply the appropriate conversion number for the liquid volume by 1.164. In other words, to convert 1 pint dry to cubic centimeters, the proper conversion number is 473.18 x 1.164, or 550.8.

Model 1: Convert 10 gallons of gasoline to liters.

Liters (liquid) = U.S. gallons x 3.785.
Therefore, 10 x 3.785 = 37.85 liters.

Model 2: Convert 15 cubic meters of cement to cubic yards.

Cubic yards = cubic meters x $\frac{1}{7.645 \times 10^{-1}}$.

Therefore, 15 x $\frac{1}{7.645 \times 10^{-1}}$ = 19.62 cu. yds.

Convert the following unit volumes as indicated.

1.28 Convert 25 pints (liquid) to liters. _____

1.29 Convert 1 quart (liquid) to cubic centimeters. _____

1.30 Convert 6 cubic centimeters to fluid ounces. _____

1.31 Convert 4 quarts (dry) to liters. _____

[redacted] Match the following unit volumes with the most appropriate converted unit volume.

1.32	_____	10 liters	a. 0.14 cubic meters
1.33	_____	5 cubic feet	b. 5.35 cubic meters
1.34	_____	7 cubic yards	c. 21.1 quarts
1.35	_____	3 liters	d. 6.34 pints
			e. 2.64 gallons

English units of weight can be converted to metric units through the application of the following procedure and the use of the conversion table.

PROCEDURE

To convert an English unit of weight to its equivalent metric unit of weight, multiply the English weight by the appropriate conversion number. Conversely, to convert the metric unit of weight to its corresponding English unit, multiply the metric unit given by the reciprocal of the appropriate conversion number:

English unit of weight x conversion number = metric weight.

Metric unit of weight $\times \frac{1}{\text{conversion number}}$ = English weight.

Weight Conversion Number Table

English Weight	Conversion Number	Metric Weight
ounces	28.35	grams
ounces	28.35×10^{-2}	kilograms
grains	64.798	milligrams
pounds	453.59	grams
pounds	4.536×10^{-4}	metric tons
pounds	4.536×10^{-1}	kilograms
tons (short)	9.072×10^{-1}	metric tons
tons (short)	907.2	kilograms

Model 1: Convert 250 pounds to kilograms.

Kilograms = pounds x 4.536×10^{-1}.

Therefore, 250 x 4.536×10^{-1} = 113.4 kilograms.

Model 2: How many ounces are in 50 grams?

Ounces = grams x $\frac{1}{28.35}$. Therefore,

50 x $\frac{1}{28.35}$ = 1.76 ounces.

Convert the following unit weights as indicated.

1.36 Convert 15 English tons (short) to metric tons. _____

1.37 Convert 150 grains to milligrams. _____

1.38 Convert 100 kilograms to pounds. _____

1.39 What is the weight in kilograms of a 65 lb. bag of cement? _____

English units of temperature can be converted to metric units through the application of the following procedure.

PROCEDURE

To convert an English unit of temperature, expressed in Fahrenheit degrees, to the equivalent metric unit of temperature, expressed in Celsius degrees, subtract 32 from the Fahrenheit temperature and multiply the result by the fraction $\frac{5}{9}$. Conversely, to convert Celsius degrees to Fahrenheit degrees, multiply the Celsius temperature by $\frac{9}{5}$ and add 32 to the result:

$$°C = (°F - 32) \times \frac{5}{9}. \qquad °F = \frac{9}{5} \times °C + 32.$$

Model 1: Convert 32°F to the Celsius scale.

$°C = \frac{5}{9} \times (°F - 32) = \frac{5}{9} \times (32 - 32)$.

Therefore, °C = 0.

Model 2: The reading on a Celsius thermometer is 30° C. What is the reading on a Fahrenheit thermometer?

$°F = \frac{9}{5} \times °C + 32 = \frac{9}{5} \times 30 + 32$.

Therefore, °F = 86.

Convert the following temperatures as indicated.

1.40 Convert 96°F to °C. _____

1.41 Convert 10°C to °F. _____

1.42 Convert 2°C to °F. _____

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Express the following measurements with the appropriate prefixes and symbols (each answer, 2 points).

1.01 $\frac{1}{10,000}$ meter _____

1.02 1,000,000 liters _____

1.03 $\frac{1}{1,000,000}$ ampere _____

1.04 50,000 grams _____

1.05 $\frac{1}{1,000,000,000}$ second _____

Convert the following unit lengths as indicated (each answer, 3 points).

1.06 Convert 15,000 feet to kilometers. _____

1.07 Convert 300 centimeters to yards. _____

1.08 Convert 440 yards to meters. _____

1.09 Convert $25\frac{1}{2}$ inches to centimeters. _____

1.010 Convert 30,000 microns (a micron is one millionth of a meter) to inches. _____

Convert the following unit areas as indicated (each answer, 3 points).

1.011 Convert 40 $in.^2$ to cm^2. _____

1.012 Convert 40,000 $ft.^2$ to hectares (1 hectare = 10,000 m^2). _____

1.013 Convert 5 cm^2 to $in.^2$ _____

1.014 Convert 10 $mi.^2$ to hectares. _____

1.015 Convert 90 $yd.^2$ to m^2. _____

Convert the following unit volumes as indicated (each answer, 3 points).

1.016 Convert 10 $ft.^3$ to m^3. _____

1.017 Convert 1,500 cm^3 to quarts (liquid). _____

1.018 Convert 17 gallons to liters. _____

1.019 Convert 3.5 liters to gallons. _____

1.020 Convert 50 quarts to liters. _____

Convert the following unit weights as indicated (each answer, 3 points).

1.021 Convert 6,000 grams to pounds. _____

1.022 Convert 450 grains to grams. _____

1.023 Convert 85 kilograms to pounds. _____

1.024 Convert $\frac{3}{4}$ ton (short) to metric tons. _____

1.025 Convert 6,000 kilograms to English tons. _____

Match the following temperatures in the left column with the appropriate temperatures on the right (each answer, 2 points).

1.026	_____ 98.6°F	a.	1,649°C
1.027	_____ 69.98°F	b.	2,800°C
1.028	_____ 5,072°F	c.	37°C
1.029	_____ 3,000°F	d.	21.1°C
1.030	_____ 110°F	e.	43.3°C

64/80

Score _____

Teacher check _____
Initial Date