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ABSTRACT

Described are the advantages of using the metric system over the English system. The most common units of both systems are listed and compared. Pictures are used to exhibit use of the metric system in connection with giving prices or sizes of common items. Several examples provide computations of area, total weight of several objects, and volume; computations are carried out in both systems. A large part of the booklet is printed in the style of posters. (SD)

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GOOD NEWS

There is much discussion today concerning change from the traditional **customary** system of measurement (the foot and pound) to the **metric** system of measurement (the meter and kilogram). American industry is already making use of the metric system, and such use is rapidly increasing. Industry is doing so because of its finding that increased metric usage is in its best interests, and in the best interests of our country.

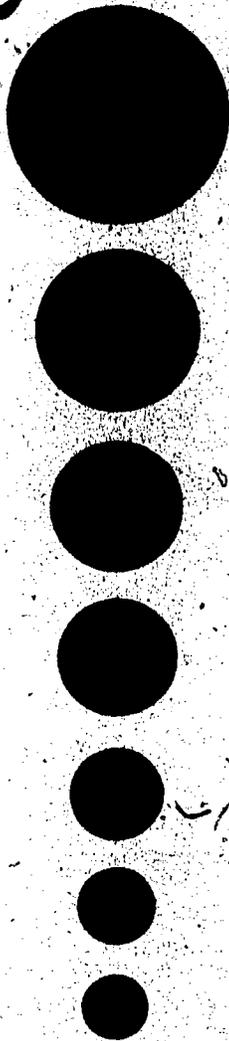
As you can see from the map on pages 6 and 7, every industrial nation on earth except the United States has officially adopted or committed itself to the use of the metric system. It is apparent that metric measurements and the metric language will be increasingly important to each of us, whether or not the Congress enacts additional metric legislation. Consequently, it is to our advantage to learn the metric language, and how to use it.

Although the metric system is different from the customary measurement system, it is **not** basically strange to us. Our country, at its founding, pioneered among the nations of the world with adoption of a decimal system for its money—a system in which currency denominations are related by tens. All of the other nations of the world have since found it to their advantage to follow our lead, with England being the last nation to place its system on a decimal basis.

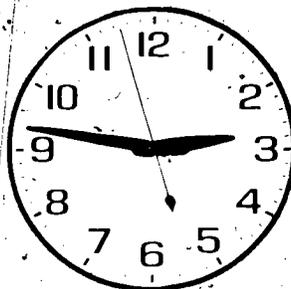
Now, we are finding it advantageous to follow the rest of the world by adopting metric—a decimal system—as our predominant but not exclusive system of measurement.

As we change to the metric system several units of measure that we currently use will not be changed. Time will continue to be measured in hours, minutes, and seconds; the rate at which we consume electric energy will continue to be measured in watts; and when we purchase a light bulb we may still refer to the number of lumens of light it will emit, as marked on the bulb or its wrapper.

No change in Money or Time



60 SECONDS =
1 MINUTE



More GOOD NEWS

You use weights and measures every day of your life. Without them, work, shopping, trade, recreation, and education would be in a state of hopeless confusion.

You learned the language of measurement so early that you have probably forgotten the day you first understood the meaning of "inch, foot, yard, and mile;" of "ounce, pound, and ton;" of "cup, pint, quart, and gallon;" of "second, minute, and hour;" and that "100 °F" is uncomfortably hot, while "30 °F" is uncomfortably cold. These are familiar units of the "customary" system of measurement that we traditionally have shared with other nations.

The worldwide trend today is toward a comparatively new system called the "modernized metric" system of measurement. The names of the units sound strange to the American ear at

first, but fortunately there are only a few words that have to be learned for everyday use.

These are: the *millimeter*, *centimeter*, *meter*, and *kilometer* for describing length and distance; the *milliliter* and *liter* for capacity or volume; the *gram*, *kilogram*, and *tonne* for weight; the *kilometer per hour* for highway speed; and the *degree Celsius* (formerly called Centigrade) for temperature.

You are already making more frequent use of the metric system than you probably realize. In international athletic competition, such as swimming and field track events, length measurements are referred to by sports reporters in *meters* rather than in yards or feet. Our astronauts, from the surface of the moon, excitedly told a worldwide audience how far their rocket had landed from a lunar hill—in *meters*. If your automobile is imported or even if it is of domestic production with a metric-designed motor,

the end wrenches or socket wrenches that you need if you want to work on your car are metric rather than customary. You already know about 35-*millimeter* film and cigarettes that are 100 *millimeters* long, or even 1 *millimeter* longer than that. You read and hear that air pollution is measured in micrograms per cubic *meter*. You see weights expressed in *grams* on more and more packaged items at the grocery store. And the trend is toward even greater use.

In science, the metric system has been in extensive use for many years, although not to the exclusion of the customary system. But today, as the problems in science become more complex, educators throughout the world are seeking to simplify computation and teaching by using the metric system in terms of everyday measurements.

meter

liter

gram

degree

Celsius

Why is the metric system being *Increasingly Used?*

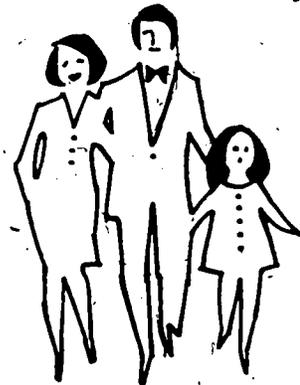
The metric system is increasing in use throughout the world for two principal reasons: It is a *simple* system, and it is a *decimal* system.

It is simple because each physical quantity, such as length or weight, has its own unit of measurement (*meter* and *kilogram*), and no unit is used to express more than one quantity. By contrast, the customary system has several units of length (inch, foot, yard, mile) or weight (ounce, pound, ton, etc.); "pound" can mean either force (as in pounds required to break a rope) or weight (as in a pound of sugar); and "ounce" can mean either volume (as the number of ounces in a quart)

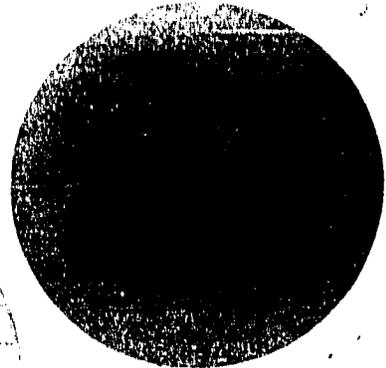
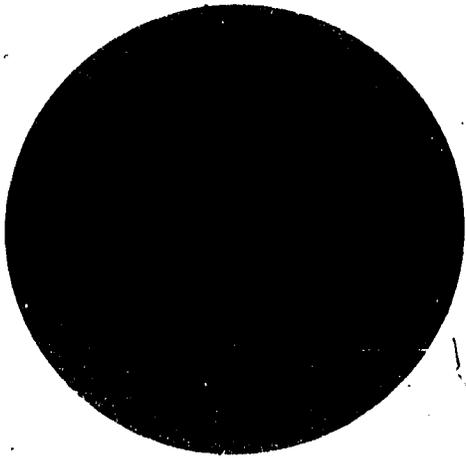
or weight (as the number of ounces in a pound). The metric system is easier than the customary system to learn to use in solving problems that involve computation. This is because metric units bear a decimal relationship to one another, as opposed to the non-decimal mixed numbers and fractions that characterize relationships between our customary units.

The U.S. monetary system has been based on decimals (factors of ten) since the founding of our country; that is, the dime equals one-tenth of a dollar and the cent equals one-hundredth of a dollar. By contrast, our customary measurement system involves units that are not decimally related to each other and thus requires the use of common fractions. Consider

the measurement of length. In the metric system a centimeter is one-hundredth of a meter; a millimeter is one-thousandth of a meter; and a kilometer is one thousand meters. In the customary system, an inch is one thirty-sixth of a yard; a foot is one-third of a yard, and a mile is 1760 yards. Centimeters are divided into millimeters, each of which is $1/10$ centimeter. But inches are divided into halves, quarters, eighths, and so forth. Therefore, computations using the decimal steps of the metric system are much simpler than those using the non-decimal mixed numbers and fractions common in our customary system.



Conversion

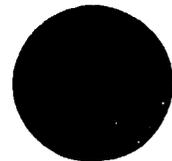


mile

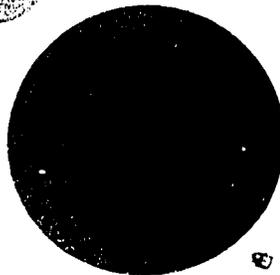
pint

ounce

inch

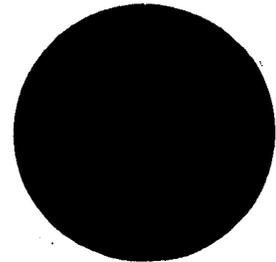


cup

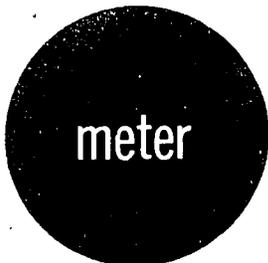


pound

foot



to order



meter



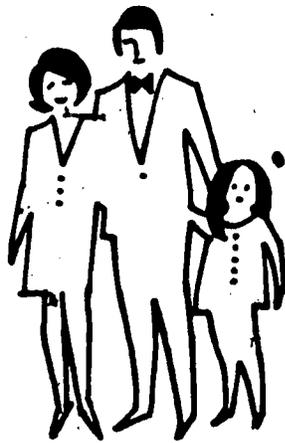
liter

ARCTIC OCEAN

PACIFIC OCEAN

UNITED STATES

ATLANTIC OCEAN



Islands in a



■ METRIC OR COMMITTED TO METRIC
□ UNCOMMITTED

ANTARCTIC OCEAN

What will the metric system mean in the Marketplace?

When metric measures become commonplace, one of the first things you will notice as you shop will be the new words for weight, volume and length on packaged goods.

Currently, in packaged foods the number of different types of measurement you encounter in one day's shopping is bewildering. Some weights are expressed in avoirdupois ounces and pounds, fluid measures are expressed in gallons, liquid quarts, pints, and fluid ounces; and dry measures are expressed in bushels, pecks, dry quarts, and pints. A dry quart

is 16 percent larger in volume than a liquid quart. By contrast, the metric system has one unit for liquid volume—the liter—or some decimal fraction or multiple thereof (e.g., the milliliter, sometimes called cubic centimeter). Only our long familiarity with the customary system has made it usable.

One important fringe benefit of the metric system that could be realized is the elimination of the need for unit pricing of food products. Our current practice for dry products, for example, is to package and label them in pounds and ounces—often with no simple pattern of package sizes. This

hodgepodge is what makes unit pricing necessary in comparative shopping. The change to metric might well be concurrent with the adoption of packaging standards under which such products could be packaged in a simple metric series of weights, such as 125, 250, 500, and 1000 grams (approximately $\frac{1}{2}$, 1, 2, and 2 pounds respectively). Multiplying the price of the smaller of any two consecutive sizes by 2 would readily show whether the larger of the two sizes is a "good buy", and by how much.



What will the metric system mean for Workers?

For workers who are involved in assembly of mechanical articles, the prospect of the changeover to metric will have little or no impact. The knowledge of metric units that they should gain quickly if consumers will enable them to carry out their duties as efficiently as in the past. Many mechanics, machinists, and assembly plant workers, however, will have to use metric tools, such as wrenches, dies, and taps, that are different in size from those now used. For a while, because of the need to maintain tools in metric and customary unit sizes, they will have a larger number of such tools from which to select the

one needed. In the long run, however, use of metric and metric tools should reduce the number of tools required and the number of sizes of fasteners and other components used in the manufacture of products, if reduced.

Sources of Additional Information

Familiarity with metric language and metric use will certainly become increasingly important to the consumer. Time spent now in learning the metric units will make it easier to use them in the years ahead. To assist you further, a chart entitled "All You Will Need to Know About Metric For Your Everyday Life" is available free of charge from the Metric Information Office, National Bureau of Standards, Washington, D.C. 20234.

For your convenience, the National Bureau of Standards has produced a pocket-sized card that will be useful in converting from customary to metric and from metric to

customary measurement units. The card may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20401, for 25 cents a copy. Order as O303-01683.

Other sources of information on the metric system include the following publications, also available from the Superintendent of Documents:

The Modernized Metric System, NBS Special Publication 304A, Revised October 1972, order as C13-10-304A, 30 cents a copy.

The International System of Units, SI, NBS Special Publication 330, 1974 Edition, order as C13-10-330-3, 65 cents a copy.

A Metric America, A decision whose time has come, NBS Special Publication 345, order as C13-10-345, \$2.50 a copy.



A comparison of the metric system and the customary system of measurement

The simplest way to compare the metric with the customary system of measurement is to place the two systems side by side. In parallel columns we will identify the metric and customary units of measurement; compare them visually; show how the two systems differ in the solution of everyday problems involving addition and multiplication; and give a few examples of how the metric system may affect your everyday life.

PREFIXES

You have probably noticed that the names of metric units sometimes include *prefixes* (milli, centi, kilo, etc.) as in milliliter, centimeter, and kilogram. These prefixes indicate multiples or submultiples of the units.

The most commonly-used prefixes, and the multiplication factors they indicate, are given below:

| Prefix | Multiplication factor |
|--------|------------------------|
| kilo | 1000 (one thousand) |
| centi | 0.01 (one hundredth) |
| milli | 0.001 (one thousandth) |

Thus, the term *kilometer* means 1000 meters; a *centimeter* is 1/100 of a meter; and a *millimeter* is 1/1000 of a meter.

Metric in everyday use

Most of us have developed a sense or feel for the customary measurement units that we use every day. We know, for example, our weight in pounds and our height in feet and inches; that a substantial individual serving of steak may weigh a pound; that our living room rug is 9 by 12 feet; that a half pint of milk is usually sufficient with a meal; and that it is uncomfortably hot on days when the temperature is 90° F.

The illustrations on the following pages are designed to give you a similar feeling for metric units, as they are used in familiar ways to measure weight, length, volume and temperature.

1 WEIGHT

Weight is related to heaviness.

2 LENGTH

Length is extent or distance.

3 VOLUME

Volume is space occupied.

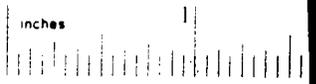
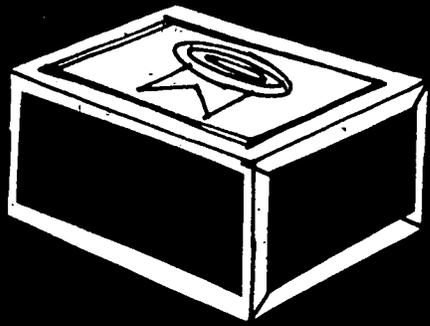
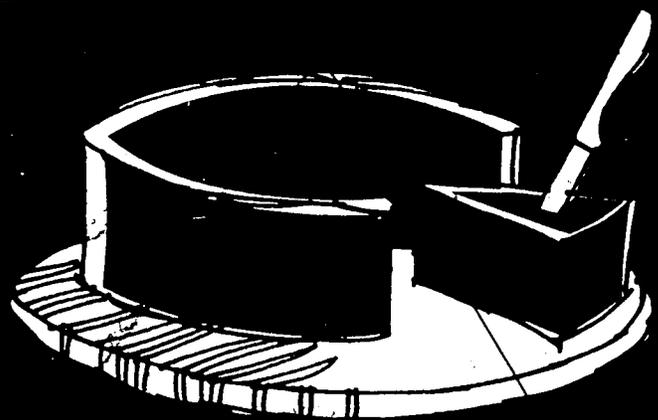
4 TEMPERATURE

Temperature is related to hotness or coldness.

METRIC Count

LE

1



30 centimeters = 1

1 WEIGHT

1 kilogram = 1000 grams
1 hectogram* = 100 grams
1 dekagram* = 10 grams
1 gram = 1 gram
1 decigram* = 0.1 gram
1 centigram* = 0.01 gram
1 milligram = 0.001 gram

2 LENGTH

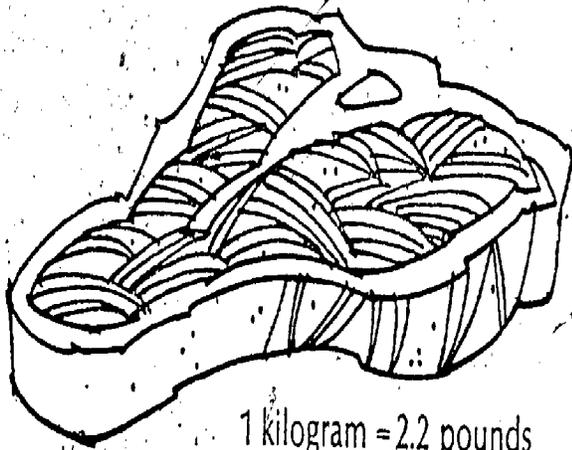
1 kilometer = 1000 meters
1 hectometer* = 100 meters
1 dekameter* = 10 meters
1 meter = 1 meter
1 decimeter* = 0.1 meter
1 centimeter = 0.01 meter
1 millimeter = 0.001 meter

3

liter
liter
liter
liter
liter
liter

4

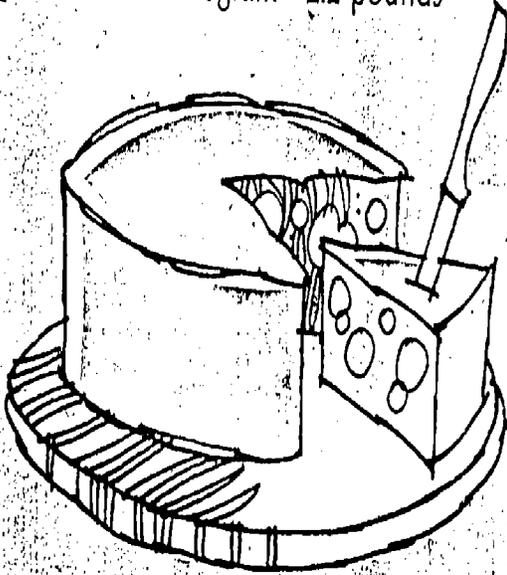
1 WEIGHT



1 kilogram = 2.2 pounds



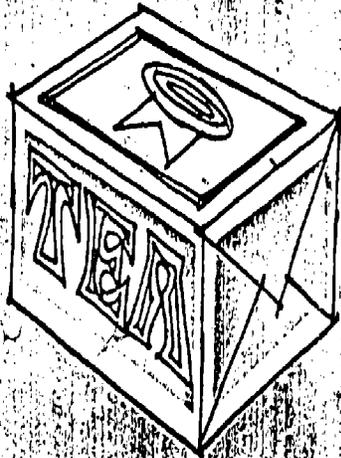
500 grams
= 1.1 pounds



250 grams = 9.0 ounces

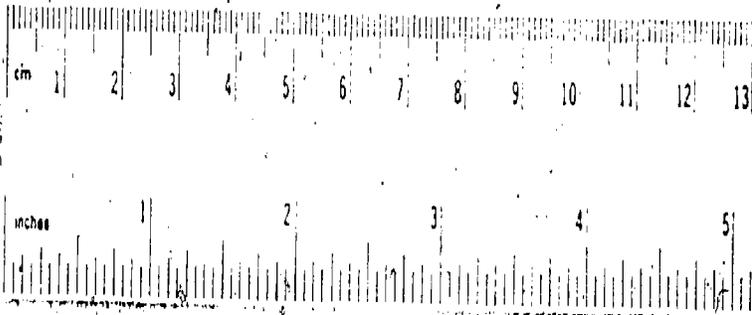
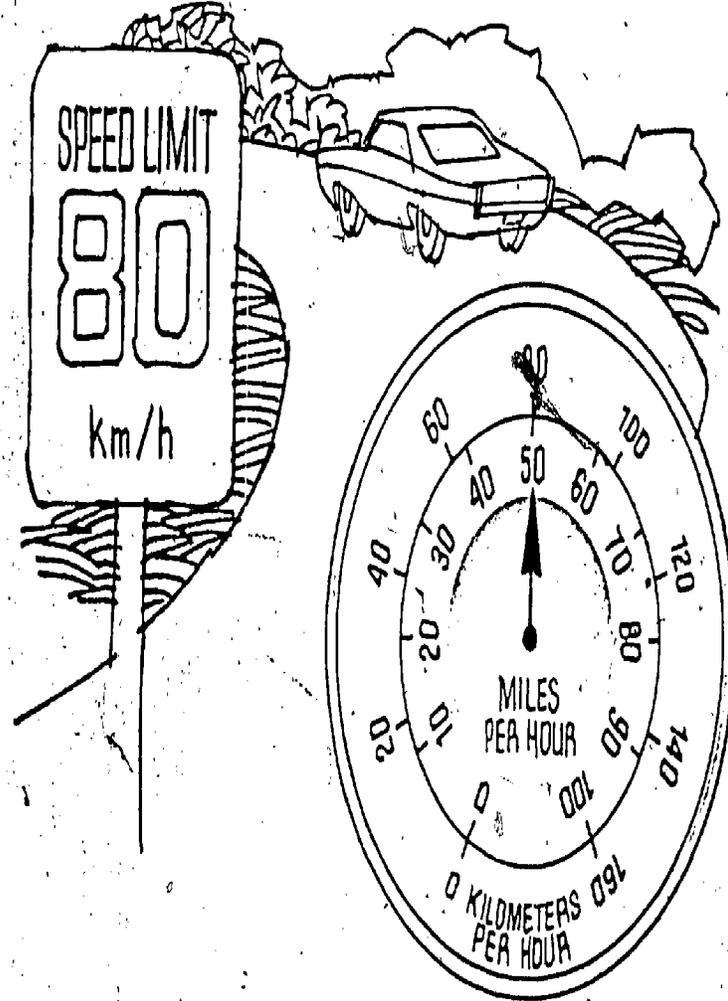


30 grams
= 1.1 ounces



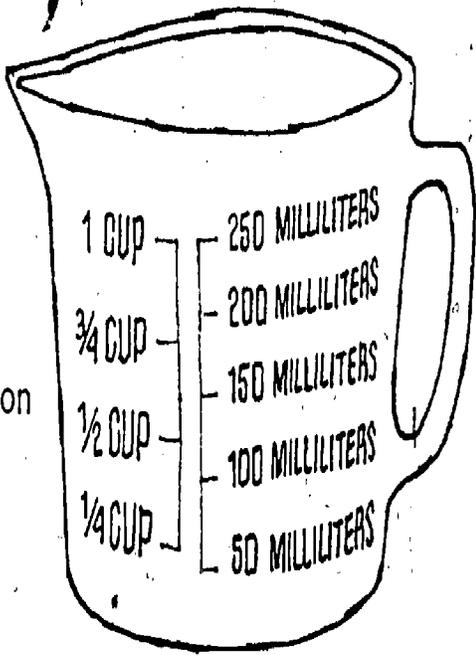
100 grams = 3.6 ounces

2 LENGTH

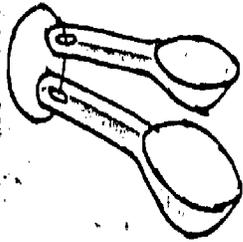


30 centimeters = 1 foot

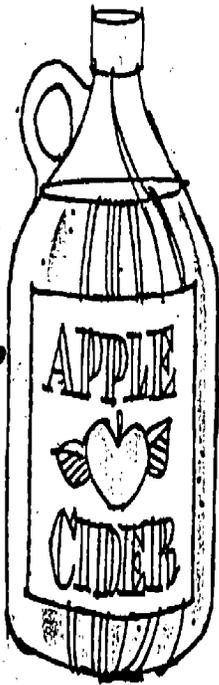
3 VOLUME



5 milliliters = 1 teaspoon



15 milliliters = 1 tablespoon



4 liters = 1.06 gallons

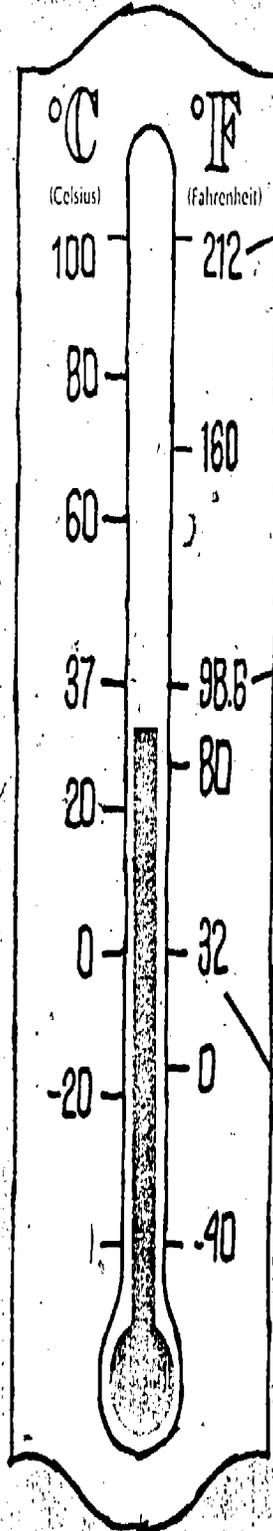


1 liter = 1.06 quarts



500 milliliters = 1.06 pints

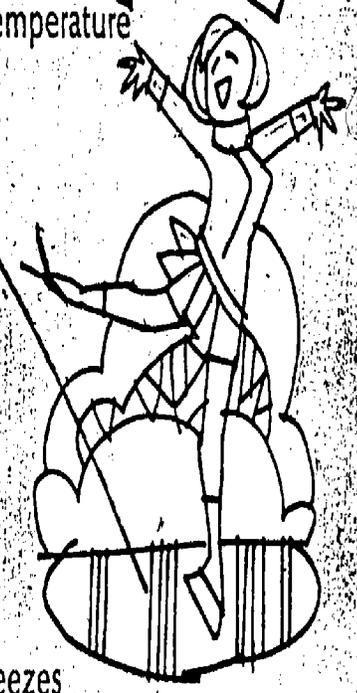
4 TEMPERATURE



water boils



body temperature



water freezes

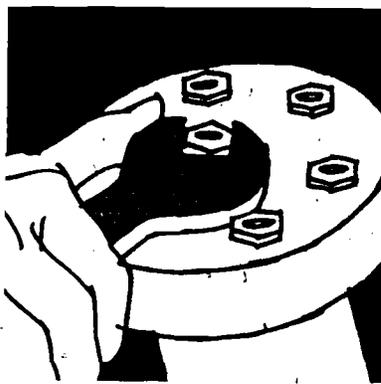
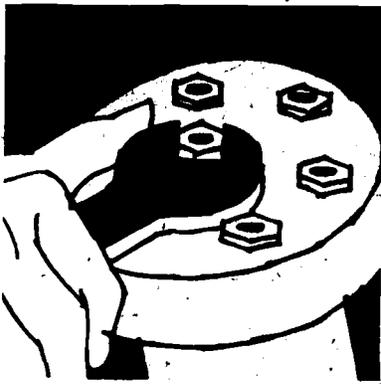
Everyday units of measurement

The units of metric and customary measure given on this page are not equivalents, except in the case of *time*, for which the metric and customary units are identical.

| Unit of Measure | The Metric System | The Customary System |
|-----------------|--|--|
| Length: | millimeter centimeter meter kilometer | inch foot yard mile |
| Weight: | gram kilogram metric ton | ounce pound ton |
| Volume: | milliliter liter | ounce cup pint quart gallon |
| Time: | second minute hour day | second minute hour day |
| Temperature: | degree Celsius | degree Fahrenheit |
| Speed: | kilometer per hour | mile per hour |
| Pressure: | pascal kilopascal | inch of mercury pound per square inch |

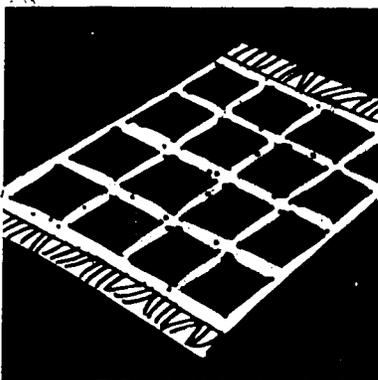
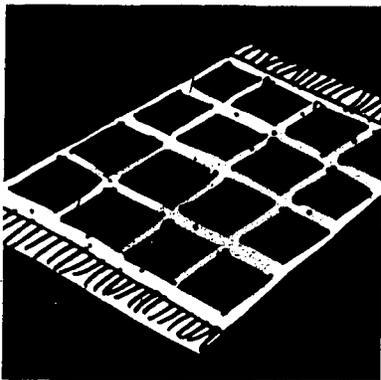
A visual comparison of metric and customary units of measurement

In the examples below, a visual comparison is made of the major units of the customary and metric systems, by using everyday quantities and sizes for purposes of illustration.



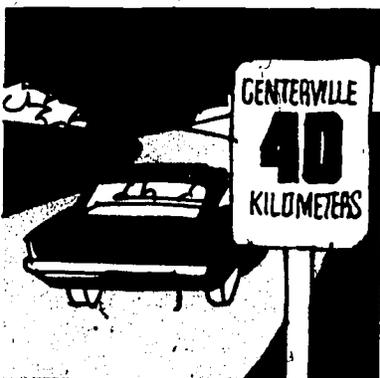
Small linear dimensions

For expressing small linear dimensions, such as wrench sizes, millimeters will replace inches. For example, a 6-mm wrench will be a more commonly-used size than a 1/4-inch wrench.



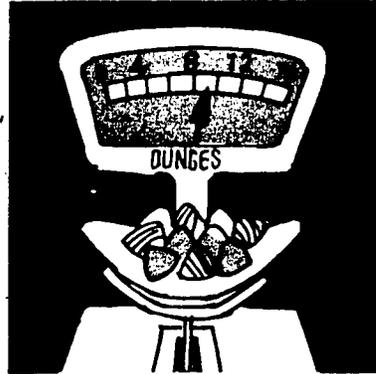
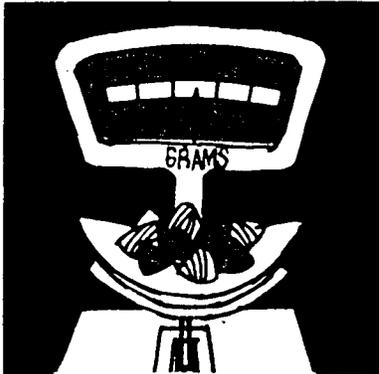
Larger linear dimensions

In expressing larger sizes, the meter will replace both the foot and the yard. In the example shown, a 3 × 4 meter carpet will generally be sold rather than a 9 × 12 foot (or 3 × 4 yard) carpet.



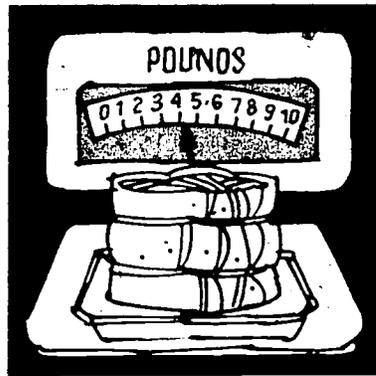
Great Distances

The kilometer will replace the mile in expressing great distances, such as distances between cities. The example shows the replacement for a sign 25 miles from Centerville: it would read 40 kilometers.



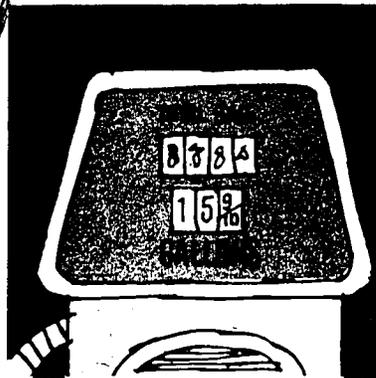
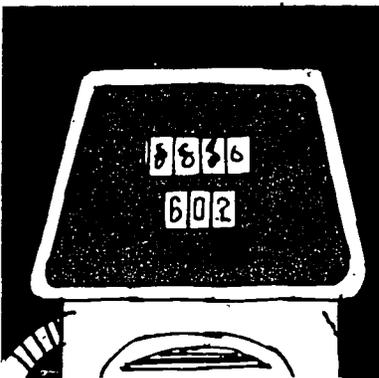
Small Weights

When we purchase small quantities of things, such as candy, we will use grams instead of ounces. For example, 250 grams will replace 9 ounces.



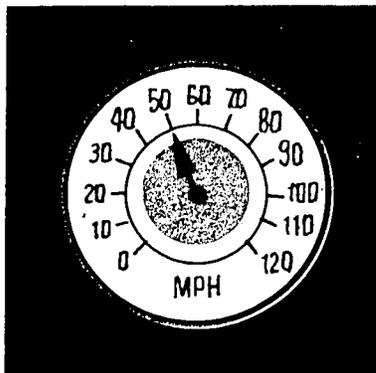
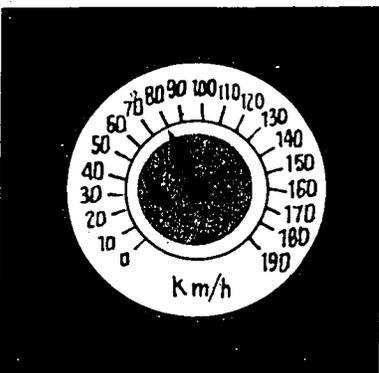
Larger Weights

The purchase of large items, such as meat, will be figured in kilograms rather than pounds. In the example shown, a 2 kilogram roast will replace a 4.5 pound roast.



Volume

When you order a tankful of gas, you may note that it will take 60 liters rather than 16 gallons.



Speed

Our automobile speedometers will change from miles per hour to kilometers per hour as the speed limit signs on our highways are likewise changed. On the speedometers shown, an 80 kilometers per hour speed replaces 50 miles per hour.

Some measurement unit Comparisons

LENGTH

Metric

1000 millimeters = 1 meter
100 centimeters = 1 meter
1000 meters = 1 kilometer

Customary

12 inches = 1 foot
3 feet = 1 yard
36 inches = 1 yard
5280 feet = 1 mile

WEIGHT

Metric

1000 grams = 1 kilogram
1000 kilograms = 1 metric ton

Customary

438 grains = 1 ounce
16 ounces = 1 pound
2000 pounds = 1 short ton

VOLUME

Metric

1000 milliliters = 1 liter
250 milliliters = 1 metric cup

Customary

2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon
8 pints = 1 gallon

Calculations

using metric and customary units

The statement and solution of three everyday problems are given in both customary and metric units, providing a side by side comparison of the systems.

a.

Problem: What is the area of the floor of a room with the following dimensions?

| | Customary Units | Metric Units |
|--------|-----------------|-----------------|
| Length | 15 ft 7 in | 475 centimeters |
| Width | 12 ft 6 in | 380 centimeters |

SOLUTION. The area is determined by multiplying the length of the room by its width. Note that for room dimensions given in mixed customary units it is necessary to first reduce them to a common unit expression which, in this case, may be either feet or inches.

CUSTOMARY— Room Dimensions in Inches

Multiply feet by 12 to convert
to inches

$$\begin{array}{l} \text{Length } (15 \times 12) + 7 = 187 \text{ in} \\ \text{Width } (12 \times 12) + 6 = 150 \text{ in} \end{array}$$

$$\begin{array}{l} 187 \times 150 \\ = 28\,050 \text{ square inches} \end{array}$$

Total square inches divided by
number of square inches in a
square foot (144) equals
number of square feet

$$\begin{array}{l} 28\,050 \div 144 = 195 \\ \text{square feet (approx.)} \end{array}$$

Total square feet divided by
number of square feet in a
square yard (9) equals number
of square yards

$$\begin{array}{l} 195 \div 9 = 22 \text{ square} \\ \text{yards (approx.)} \end{array}$$

METRIC— Room Dimensions in Centimeters

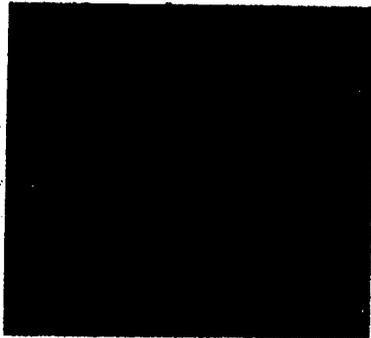
$$\begin{array}{l} \text{Length } 475 \text{ cm} \\ \text{Width } 380 \text{ cm} \end{array}$$

$$\begin{array}{l} 475 \times 380 \\ = 180\,500 \text{ square cm} \end{array}$$

Total square centimeters
divided by number of square
centimeters in a square meter
(10 000) equals number of
square meters; i.e. move
decimal point 4 places to left

$$\begin{array}{l} 180\,500 \div 10\,000 = \\ 18 \text{ square meters} \\ \text{(approx.)} \end{array}$$

b.



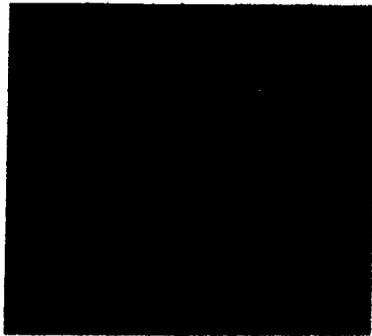
What is the algebraic expression for the perimeter of a square? How
many sides does it have?

| | |
|---|-----------|
| What is the algebraic expression for the perimeter of a square? | <i>4s</i> |
| How many sides does it have? | 4 |

What is the algebraic expression for the area of a square? How
many sides does it have?

| | |
|--|-------|
| What is the algebraic expression for the area of a square? | s^2 |
| How many sides does it have? | 4 |

C.



Perimeter

What is the algebraic expression for the perimeter of a square? How
many sides does it have?

| | |
|---|------|
| What is the algebraic expression for the perimeter of a square? | $4s$ |
| How many sides does it have? | 4 |

What is the algebraic expression for the area of a square? How
many sides does it have?

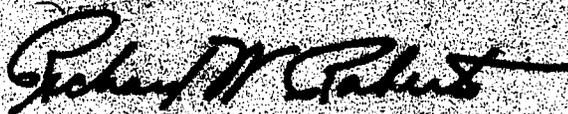
| | |
|--|-------|
| What is the algebraic expression for the area of a square? | s^2 |
| How many sides does it have? | 4 |

A Word from the Director

From the present to the future, the accuracy of measurements in the metric system is essential to the consumer's economic well-being. Consumer confidence by government, business, and industry in the metric system, business and industry, is essential to the economy.

The National Bureau of Standards was established in 1901 to meet the needs of a growing metric measurement system. The primary responsibility of NBS is to serve, for the nation, as the authoritative source of accurate, compatible, and usable physical measurements. Working with state and federal agencies, universities, industry, and many special groups, NBS helps ensure the integrity of measurements used throughout the United States.

In keeping with its vital role in measurement science, the National Bureau of Standards is under special obligation to provide consumers with useful information on the metric system, at a time when its use is increasing. We hope that this booklet has proved to help you understand how change to the metric system will affect you and how to use it in your daily life.



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