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ABSTRACT

The purpose of this booklet is to make it easier for the parent to help his/her child learn the metric system. Contents include: (1) answers to most-asked questions of parents; (2) introduction to metric units; (3) converting from one unit to another within the metric system; (4) a reference table; and (5) a chart entitled "All You Will Need to Know About Metric (For Your Everyday Life)." (MP)

METRICS THE MEASURE OF YOUR FUTURE

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A PARENT'S GUIDE TO HOMEWORK

For use in the Winston-Salem/Forsyth County School System

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ESEA Title III - Grant No. 43-74-259
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February 1976

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NOTE TO PARENTS:

The purpose of this booklet is to make it easier for you to help your child learn the metric system. You may or may not know it very well yourself. And if you grew up in this country, it may seem strange to you for a long time, as it does to those of us who work in the schools. Maybe you would rather not change - some of us may agree with you. But it is a fact that all other industrialized nations will use the metric system in the future, and increasingly so will we. Common sense tells us we must make our products acceptable to the rest of the world or lose their trade, with drastic ecomonic results.

So the jobs of the future will require a knowledge of the metric system - many already do. The sooner we can get children started with metrics, the easier it will be for them. If they learn metric measurements during elementary school or junior high, they will never have to meet the far more difficult task of changing from one system to another.

But measurement is not just something that is learned in an arithmetic class. It includes a lot of understandings and activities that develop gradually over a long period of time. It begins when the newborn infant is measured and weighed and continues as he observes formulas prepared, food served, clothing fitted, and objects compared. By the time he is nine year old, the child usually has learned what it means to measure length, weight and capacity; by the time he is twelve or thirteen, he generally understands area and volume and has acquired the basic measurement skills for his daily life. Beyond this he may need to learn specialized measures for his vocation, hobbies and other interests.

In our schools, we will try to make nearly all our measurement activities metric. A few will not be - we want children to understand those who have not yet gone metric, too.

And at home, we ask that you help by using some of the hints we offer here. Make some metric measuring tools; look for metrics on any new ones you buy. Use them often around your home, so that your child can see that you consider them important. Talk with him about what he measures, and encourage him to think metric first. Then for him, using metrics will just be a natural, easy way to get a necessary job done.

Answers to 5 most-asked questions of parents

1. Why should we change to metric?

Because over 95% of the people in the world are using it. We want to be able to understand what they say and write, and we want them to understand us, especially when it concerns selling and buying manufactured goods, machines, tools, and repair parts.

2. Won't it be hard to learn?

No. It is a decimal system, like our money, and much easier to learn and use than our customary way. Elementary students will have no problem with it. Secondary students and adults will soon "think metric," too. There are only a few new words to learn, and you don't have to know them all at once. Just notice metric measurements all around you now - you will be suprised at how often they are used already and how little it bothers you.

3. How can I get started?

Make a meter stick. Start with a strip of cardboard or wood 40 inches long (bet you had to measure that - we don't really know how long a yard or an inch is unless we measure!) Use the centimeter ruler on the front of this paper to mark it off in centimeters; one hundred centimeters is one meter. Cut off the extra length - less than an inch. Now look at your pencil or pen. Estimate how many centimeters long it is. Measure it. Estimate the width of your desk or table. Measure it. Estimate...measure. In no time you will be as accurate with meters and centimeters as you are with yards and inches.

4. Can I also make a liter measure?

That's easy. A wide-mouthed quart mayonnaise jar filled to the top is a liter. A quart milk carton with the spout open holds a liter. A ten-gallon can holds about 38 liters. Besides, how long is it since you measured anything by the gallon (the gas pump does the measuring!)

5. But what about those little grams?

No problem. You seldom weigh a single paper clip or thumb tack. Mostly you weigh yourself or look at the weight of things you are buying. A pound is about 450 grams. One kilogram is 2.2 pounds. Ten kilograms - 22 pounds. When grocery stores start selling by the kilogram, they will start using metric scales. Until then, learn from the packaged food you buy. And if you buy any measuring equipment, be sure it has metric markings!

6. If it is so easy, why didn't we change to metrics long ago?

Sorry, I have found no logical answer for that one. People tend to avoid the unfamiliar, and forget that to live is to change. One thing is sure. We can learn, and we are changing.

So What IS a Meter, Really?

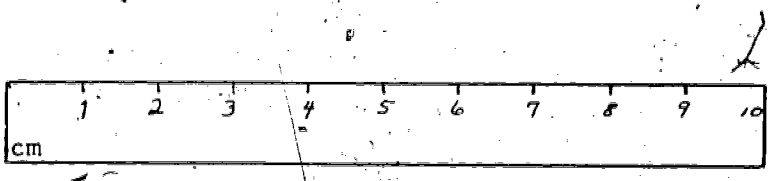
The meter is the base unit of the metric system. It was chosen originally as 1/10,000,000 of the distance from the equator to the North Pole -- a "natural" part of the earth itself. Scientists then believed the earth to be a sphere. Now that we know that the world is not in perfect shape (!), the meter is defined in terms of krypton-86 wavelengths.

The meter is a little longer than our customary yard, a bit over 39 inches. It is divided into 10 equal parts called decimeters (deci means one tenth; ten decimeters make one meter). Your hand is probably about a decimeter wide.

Each decimeter is divided into 10 equal parts called centimeters (centi means one hundredth; one hundred centimeters make one meter). Your little fingernail is probably about a centimeter wide.

Each centimeter is divided into 10 equal parts called millimeters (milli means one-thousandth; one thousand millimeters make one meter). A dime is about one millimeter thick.

The meter will be used to measure length, area (in square meters), and volume (in cubic meters). A special name for the cubic decimeter is liter which is slightly more than the liquid quart. And one liter of pure, cold water has a mass of one kilogram.



10 centimeters = 1 decimeter
100 centimeters = 1 meter

10 millimeters = 1 centimeter
1 000 millimeters = 1 meter

Spell that for me, please...

Chances are, if you say that to someone writing a paragraph about metric measurements, that he will become uneasy or defensive. The problem comes from two hundred years of increasing metric usage without any truly international agreement. As each nation used the system, it spelled the words in a way that seemed compatible with its own language. Those with French connections kept metre and litre. Others settled on such variations as meter (most English-speaking nations), metr, metro, etc.

When the metric system was modernized in 1960 by the General Conference on Weights and Measures, the resulting version was called the Systeme International, usually referred to as SI. We now use these preferred spellings and symbols for the most commonly used words and prefixes:

meter	m	kilo	k
liter	l (L in U. S.)	hecto	h
gram	g	deka	da
Celsius	C	deci	d
second	s	centi	c
metric ton	t	milli	m

We will use these in teaching the metric system, hoping that eventually everyone will accept a common form, but we know that other spellings will still be in use for a long time. They aren't wrong, and they won't trouble us when others use them. Maybe in years to come they will even be the "preferred" way. Until then, in our classes we will try to use SI forms.

There are some preferred ways of writing metric measurements, too. For example, the prefix and the unit name are not separated:

write milligram not milli gram

Words are made plural by adding an s, but symbols are not:

write 15 kilograms = 15 kg not 15 kgs

Symbols are separated from the number they identify by a space:

write 142 kg not 142kg

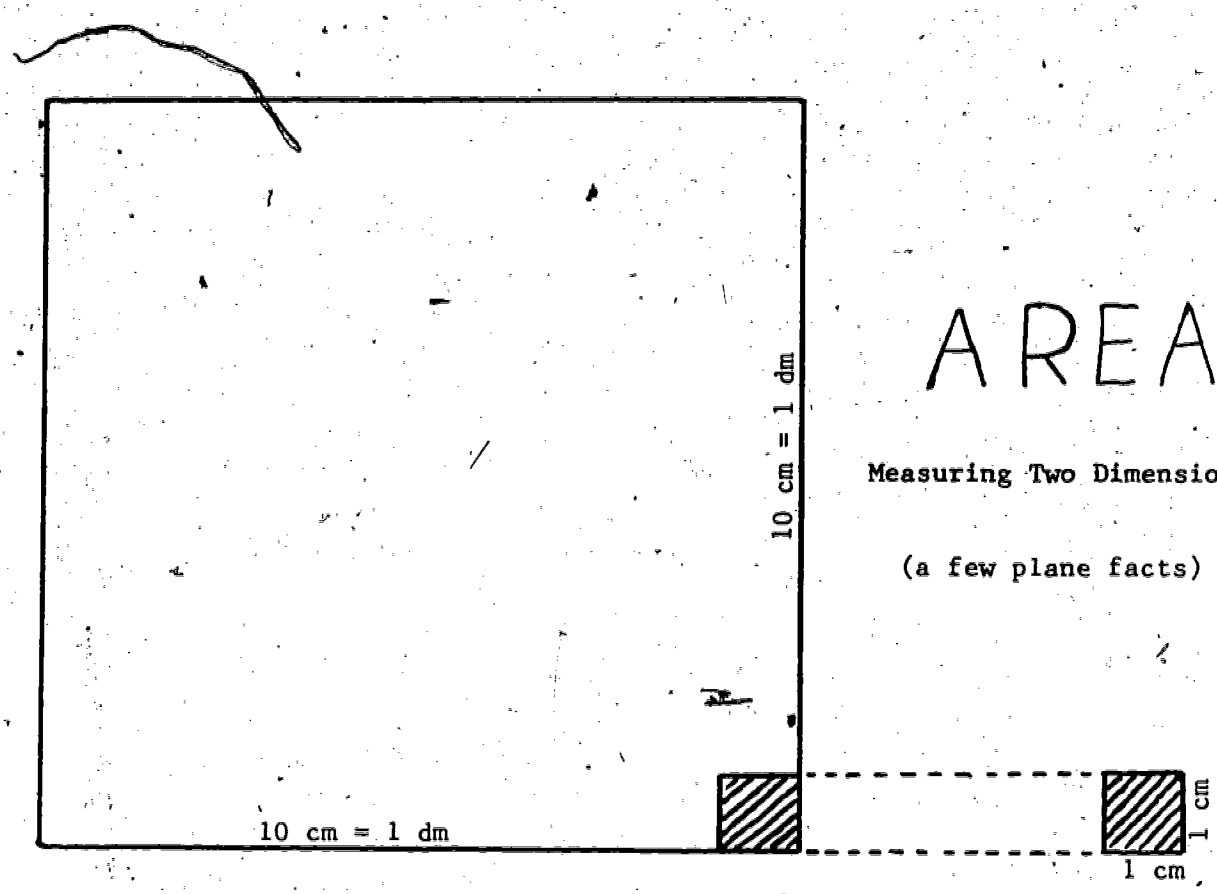
Large numbers are separated into groups of three digits but without commas (many people in other countries use a comma for the decimal point and periods only at the end of a sentence).

write 15 942.6 km not 15,942.6 km

Use a decimal to express partial units rather than common fractions; use a zero before the decimal point when the measure is less than one unit:

write 0.25 m not ¼ m

In the long run, all the people of the world will have a hand in deciding whether these SI standards are the best ones for future use - if not, they will surely be changed!



AREA

Measuring Two Dimensions

(a few plane facts)

$10 \text{ cm} \times 10 \text{ cm} = 100 \text{ cm}^2$
$1 \text{ dm} \times 1 \text{ dm} = 1 \text{ dm}^2$
therefore $100 \text{ cm}^2 = 1 \text{ dm}^2 = 1$ square decimeter

$1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^2$
or 1 square centimeter

$10 \text{ dm} = 1 \text{ m}$
$10 \text{ dm} \times 10 \text{ dm} = 100 \text{ dm}^2 = 1 \text{ m}^2 = 1$ square meter

Notice that <u>each square unit is 100 times</u> as great as the next smaller square unit.

So $1 \text{ dam}^2 = 100 \text{ m}^2$
$1 \text{ hm}^2 = 100 \text{ dam}^2$
$1 \text{ km}^2 = 100 \text{ hm}^2$

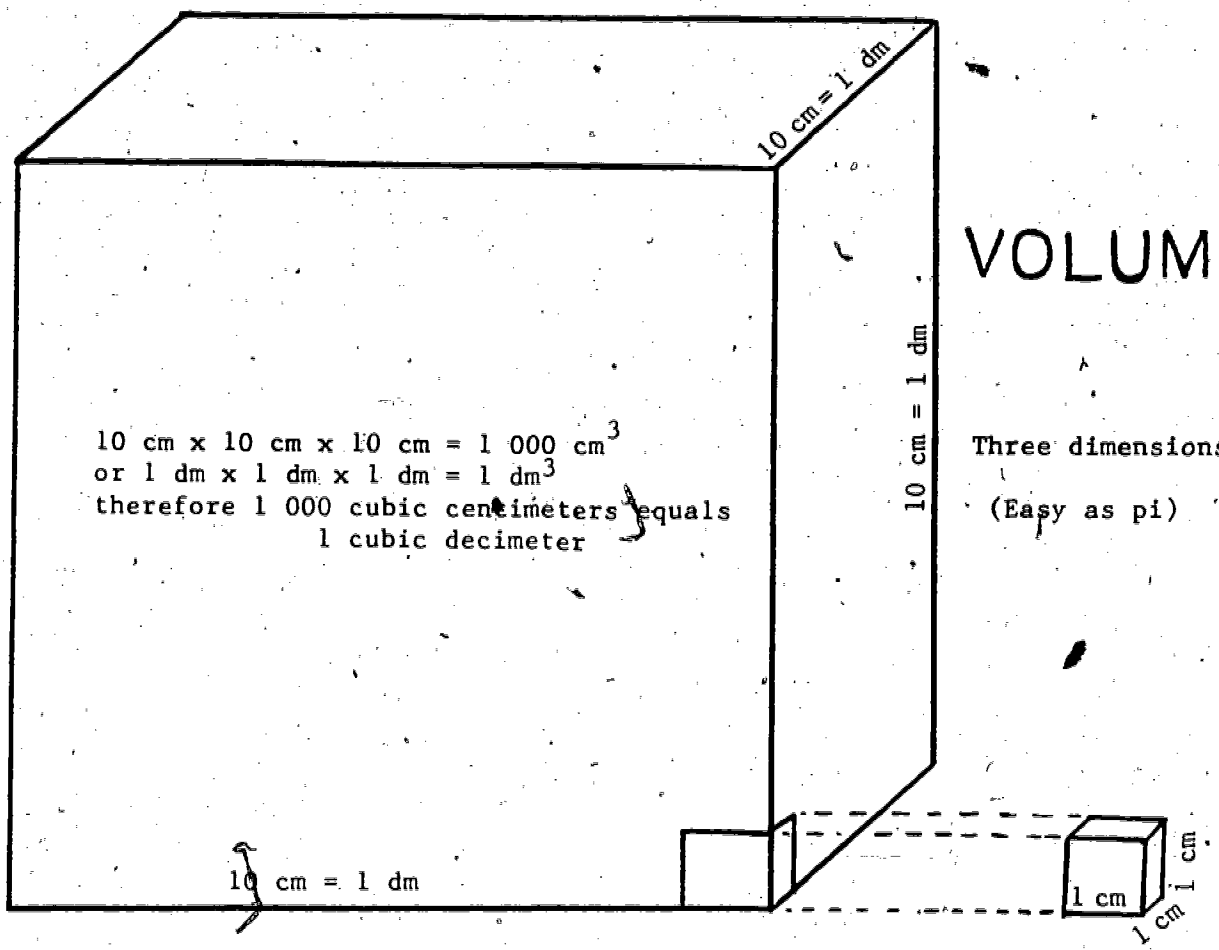
The square dekameter is usually called an <u>are</u> (1 a), and is about the size of half a tennis court. The square hectometer is usually called a hectare (1 ha) and is about 2.5 acres. These terms are used for land measure. Square kilometers are used to measure a county, state, or other large area.

Square meters are just right for buying carpet (a little more than a square yard). And square centimeters work best for measuring small areas like the size of a postage stamp or a snapshot.

VOLUME

Three dimensions

(Easy as pi)



10 cm x 10 cm x 10 cm = 1 000 cm^3
or 1 dm x 1 dm x 1 dm = 1 dm^3
therefore 1 000 cubic centimeters equals
1 cubic decimeter

1 dm^3 = 1 000 cm^3
1 m^3 = 1 000 dm^3

1 cm x 1 cm x 1 cm = 1 cm^3
or 1 cubic centimeter

Note that each cubic unit is 1000 times the next smaller cubic unit. Remember, too, that 1 dm^3 = 1 liter and 1 cm^3 = 1 milliliter. An extremely valuable relationship of the metric system is illustrated by these facts:

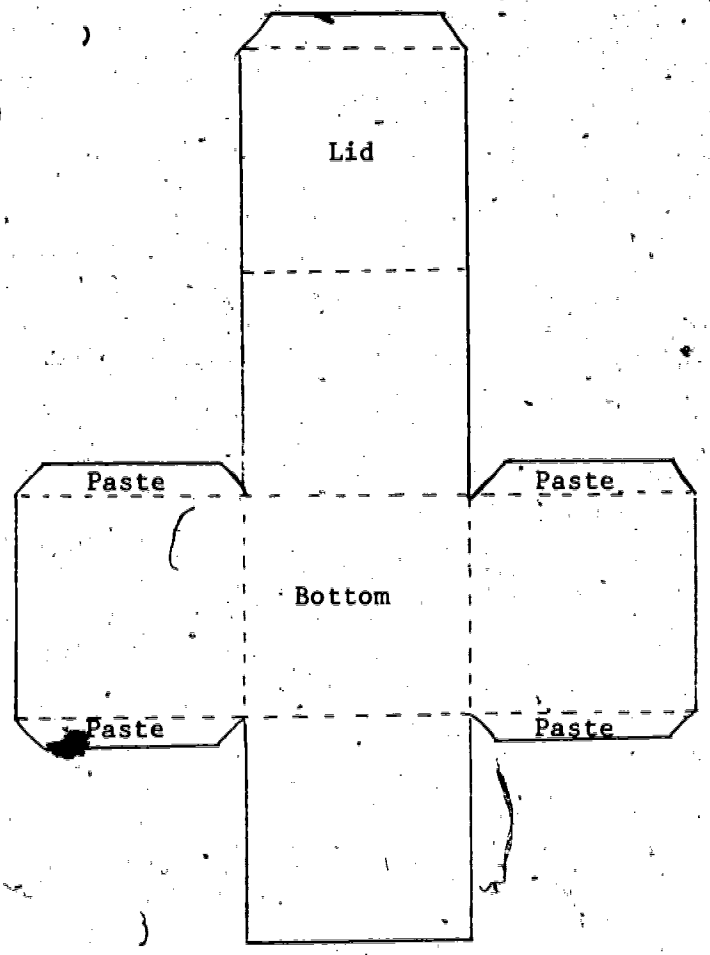
1 cubic centimeter of cold water = 1 milliliter and weighs 1 gram
1 cubic decimeter of cold water = 1 liter and weighs 1 kilogram
1 cubic meter of cold water = 1 kiloliter and weighs 1 000 kg or 1 metric ton

Notice that you could easily determine the volume or capacity of any container by weighing the cold water it will hold, regardless of its shape. That is a lot easier than $V=\pi r^2 h$, the formula for the volume of a cylinder.

THE LITER

a HOLDING pattern

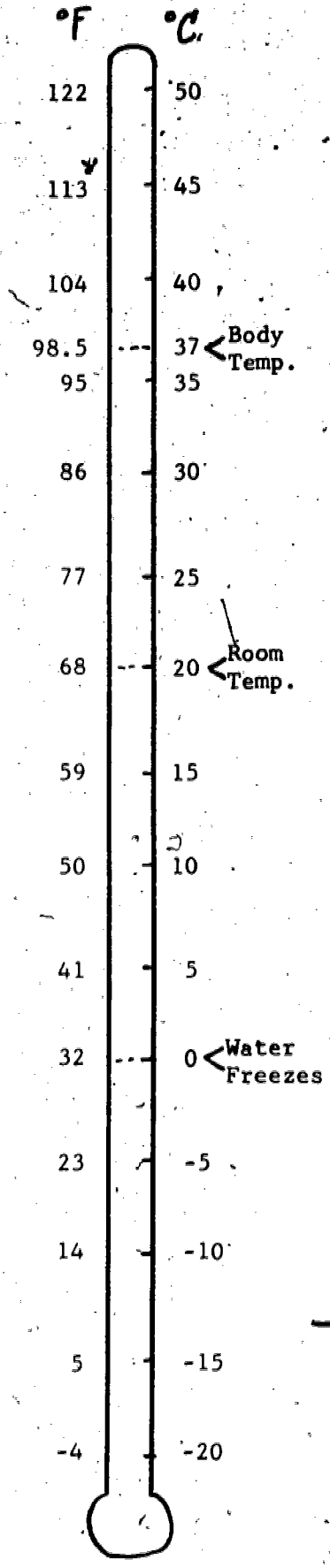
If you make a box using a pattern shaped like this with each side a square decimeter, the box will hold <u>one liter</u>.

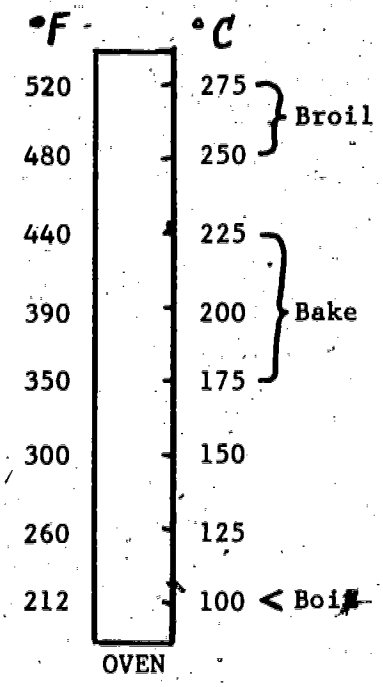


Things that pour, or do not hold a shape well, are usually measured in liters. Since a liter is just slightly larger than a quart, you will buy the same number of liters of milk as you have been buying quarts. But your gasoline tank will hold nearly four times as many liters as gallons; watch the price - it should be just a little more than one-fourth that of a gallon.

Smaller quantities are measured in milliliters - it takes five to fill a teaspoon, fifteen for a tablespoon, 240 for a 'standard' measuring cup, and 1 000 milliliters to fill a liter measure.

A kiloliter is 1 000 liters and is sometimes used for measuring the capacity of large containers like storage tanks, dye vats, or swimming pools. Remember, a kiloliter of cold water will fill a cubic meter and weigh a metric ton. Now that's a waterbed!





Celsius is the name of the man who invented the temperature scale we used to call centigrade - it has been renamed in his honor.

- Water boils at 100 degrees Celsius.
- Water freezes at 0 degrees Celsius.
- We are asked to keep our homes below 20 degrees Celsius in winter to conserve fuel.

TEMPERATURE

MASS -- a Matter of Weight

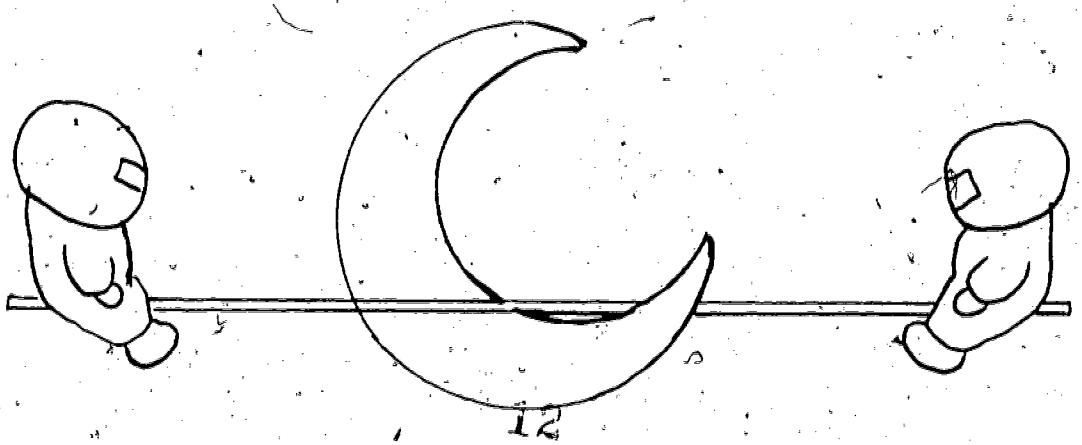
"Mass? Doesn't that really mean weight?" A few years ago, hardly anyone ever asked such questions. But when space travel became a reality, we began hearing much talk about "weightlessness" and many statements like "The weight of our astronauts on the Moon is only one-sixth of that on Earth."

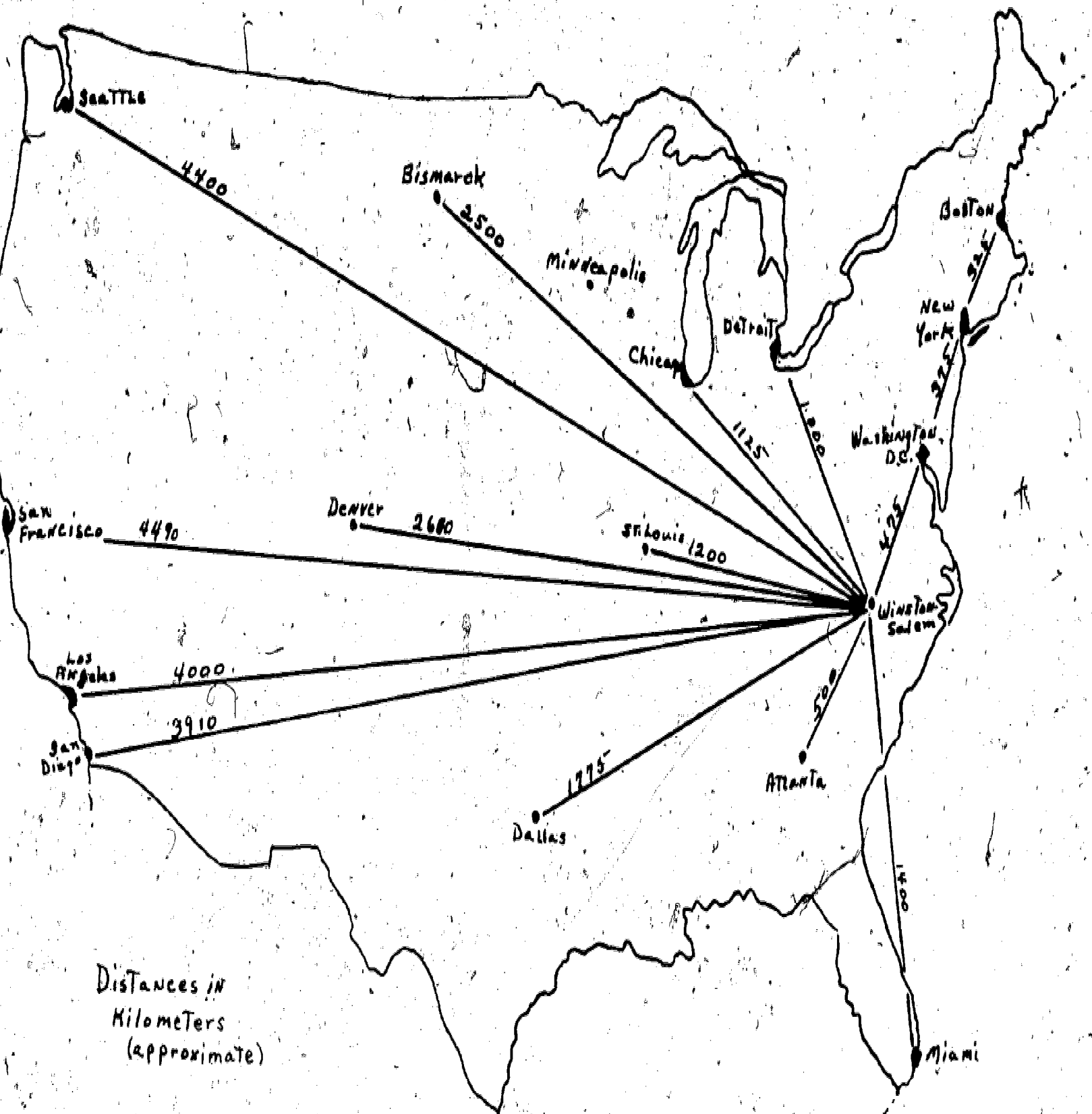
The confusion grew out of the fact that scientists used the words weight and force as though they meant the same thing, while the general public used weight and mass to mean the same. But force does not mean mass.

In order to understand and talk about events in space, we need to be precise in our language. Technically, mass is the quantity of matter in an object; force is any push, pull or attraction such as gravity that causes an object to move. The astronaut on the Moon still has the same body -- his mass does not change. But the force of gravity on the Moon is much less than on Earth. Out in space it may approach zero, so objects float about freely, whatever their mass.

In changing to the metric system we will try to eliminate this confusion in our language. In science and technology the confusing word weight will be avoided. Statements like the one above will be revised to say more precisely "The force of gravity on our astronauts on the Moon is only one-sixth of that on Earth." Scientists will measure force in newtons, and everyone will measure mass in kilograms.

So we will continue to watch our weight, as we always have. Two objects with the same mass or weight will balance on a simple scale or on a seesaw, whether on the Earth or on the Moon. When we talk about how heavy things are, we will use the words kilogram and gram, as appropriate. A kilogram is a little over two pounds. In the metric system, the prefix kilo always means thousand, so a kilogram is one thousand grams.




Seattle
4400
Bismarck
2500
Minneapolis
Chicago
1125
Detroit
1200
Boston
New York
Washington D.C.
San Francisco
4490
Denver
2680
St. Louis
1200
Winston-Salem
Los Angeles
4000
3910
San Diego
1775
Dallas
Atlanta
500
Miami
Distances in Kilometers (approximate)

AN OUTLINE OF HISTORY - METRIC, THAT IS

1670 Gabriel Mouton, Vicar of St. Pauls Church in Lyons, proposed a decimal system based on an arc of a great circle of the earth.

1786 Decimal system of coinage, developed by Thomas Jefferson and Robert Morris, adopted by Congress - base unit the dollar.

1790 Decimal system of weights and measures proposed by Jefferson but rejected.

1795 Metric system developed by the French Academy of Science made mandatory in France (and imposed on Holland and Belgium in defeat).

1798 First International Conference on Weights and Measures called by Talleyrand.

1821 John Quincy Adams recommended that the United States not change until both England and Spain agreed. They did not.

1850 Spain, Greece, Norway and part of Italy adopted the metric system.

1866 Act of Congress made metric system legal but not mandatory in the U.S.

1868 Germany and Portugal adopted the metric system.

1875 U.S. signed "Treaty of the Meter" with 17 countries.

1893 All United States measurements redefined in terms of the meter.

1960 SI Metric System adopted by Eleventh General Conference - this modernized version amounts to an international language of weights and measures.

1965 England goes metric and changes to a decimal money system.

1968 Congress orders a study of the probable effects of making the metric system mandatory and asks for recommendations.

1970 Canada adopts a conversion plan.

1971 Study Commission reports that the United States is gradually going metric on a voluntary basis; that the change will be easiest and least expensive if carried out over a carefully planned ten-year period; and that educational efforts must be increased to meet work force needs.

1974 Congress passes Public Law 93-380 "...to encourage educational agencies and institutions to prepare students to use the metric system..."

1975 Congress passes Public Law 94-168 to set up a Metric Conversion Board to plan U.S. conversion. We have joined the metric world!

RELATIONSHIPS WITHIN THE METRIC SYSTEM

1	kilometer	=	10	hectometers	=	100	dekameters	= 1 000 meters
0.1	kilometer	=	1	hectometer	=	10	dekameters	= 100 meters
0.01	kilometer	=	0.1	hectometer	=	1	dekameter	= 10 meters
0.001	kilometer	=	0.01	hectometer	=	0.1	dekameter	= 1 meter
1	meter	=	10	decimeters	=	100	centimeters	= 1 000 millimeters
0.1	meter	=	1	decimeter	=	10	centimeters	= 100 millimeters
0.01	meter	=	0.1	decimeter	=	1	centimeter	= 10 millimeters
0.001	meter	=	0.01	decimeter	=	0.1	centimeter	= 1 millimeters

Note: The Metric System is consistent. In the above table, liter or gram may be substituted for meter and the table is still true.

AREA IN THE METRIC SYSTEM

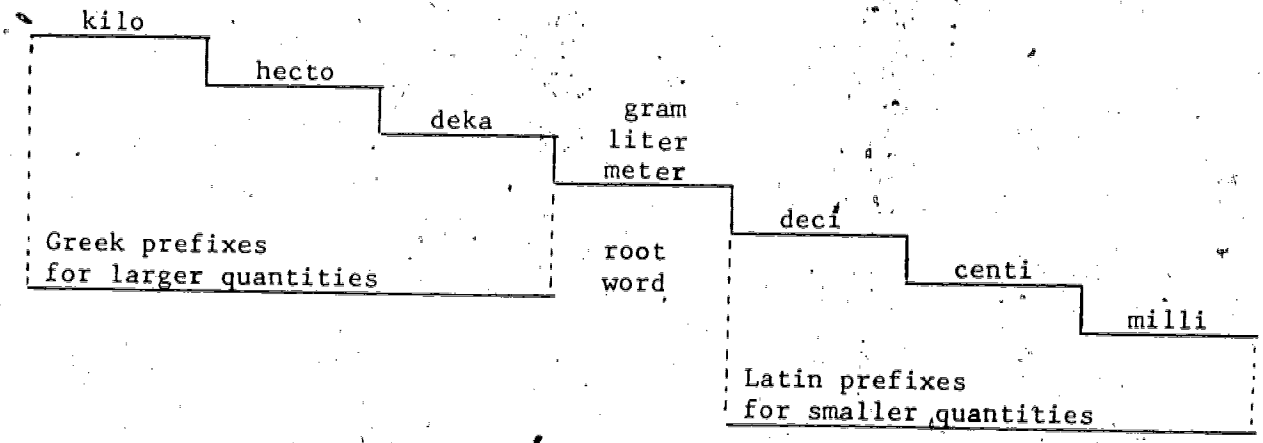
Measure	Symbol	Relationship
Square centimeter	cm^2	$1\ cm^2 = 100\ mm^2$
Square decimeter	dm^2	$1\ dm^2 = 100\ cm^2$
Square meter	m^2	$1\ m^2 = 100\ dm^2$
Are (Sq. dekameter)	a	$1\ a = 100\ m^2$
Hectare (Sq. hectometer)	ha	1 ha = 100 a = 2.5 acres
Square kilometer	km^2	$1\ km^2 = 100$ ha

VOLUME IN THE METRIC SYSTEM

Measure	Symbol	Relationship
Cubic centimeter	cm^3	$1\ cm^3 = 1\ 000\ mm^3$
Cubic decimeter	dm^3	$1\ dm^3 = 1\ 000\ cm^3$
Cubic meter	m^3	$1\ m^3 = 1\ 000\ dm^3$
		$1\ cm^3 = 1$ mL
		$1\ dm^3 = 1$ L
		$1\ m^3 = 1$ kL

metre = meter
litre = liter

CONVERSIONS
(one step at a time)



Each unit is 10 times as large as the next one to its right, and one-tenth as large as the next one to its left. Example: 1 hectogram = 10 dekagrams
1 hectogram = 0.1 kilogram

Since the metric system is a decimal system, it is easy to change from one unit to another. Simply count the number of steps from the unit to the other, and move the decimal that many steps in the same direction. (If you need to use an empty space, fill it with a zero!)

Example 1: 1.4 hectograms = ___?___ grams

From hectogram to gram is two steps to the right; therefore the decimal moves two places to the right.

Answer 1: 1.40 hectograms = ___140___ grams (Note the zero.)

Example 2: 275 grams = ___?___ kilograms

From grams to kilograms is three steps left; therefore move the decimal three places left.

Answer 2: 275 grams = ___0.275___ kilograms (Note the zero.)

Note: The metric system is consistent; meter or liter may be substituted for grams and the examples are still true.

HOW TO CHANGE FROM ONE UNIT TO ANOTHER WITHIN THE METRIC SYSTEM

When you are given	You multiply by this number to change to						
	millimeters	centimeters	decimeters	meters	dekameters	hectometers	kilometers
mm	1	0.1	0.01	0.001	0.000 1	0.000 01	0.000 001
cm	10	1	0.1	0.01	0.001	0.000 1	0.000 01
dm	100	10	1	0.1	0.01	0.001	0.000 1
m	1 000	100	10	1	0.1	0.10	0.001
dam	10 000	1 000	100	10	1	0.1	0.01
hm	100 000	10 000	1 000	100	10	1	0.1
km	1 000 000	100 000	10 000	1 000	100	10	1

SOME VERY LARGE MEASURES:

megameter = 1 000 kilometers

gigameter = 1 000 megameters

terameter = 1 000 gigameters

SOME VERY SMALL MEASURES:

micrometer = 0.001 millimeter

nanometer = 0.001 micrometer

picometer = 0.001 nanometer

femtometer = 0.001 picometer

attometer = 0.001 femtometer

NOTE:

The Metric System is consistent. In the above, liter or gram may be substituted for meter and the tables are still true.

METRIC REFERENCE TABLE

Root Word	Added Prefix	Prefix Means	Results	Written as a Measure	Written as a Unit	For Daily Use	Approximate Equivalent
	milli	1/1000	1 millimeter	0.001 m	1 mm	yes	0.039 inches
	centi	1/100	1 centimeter	0.01 m	1 cm	yes	0.39 inches
	deci	1/10	1 decimeter	0.1 m	1 dm	avoid	
(1) METER			1 meter	1 m	1 m	yes	39.37 inches
	deka	10	1 dekameter	10 m	1 dam	avoid	
	hecto	100	1 hectometer	100 m	1 hm	avoid	
	kilo	1000	1 kilometer	1 000 m	1 km	yes	0.62 miles
	milli	1/1000	1 milliliter	0.001 L	1 mL	yes = 1 cm^3	0.03 fluid ounce
	centi	1/100	1 centiliter	0.01 L	1 cL	avoid	
	deci	1/10	1 deciliter	0.1 L	1 dL		
(2) LITER			1 liter	1 L	1 L	yes = 1 dm^3	1.06 quarts
	deka	10	1 dekaliter	10 L	1 daL	avoid	
	hecto	100	1 hectoliter	100 L	1 hL	avoid	
	kilo	1000	1 kiloliter	1 000 L	1 kL	yes = 1 m^3	264 gallons
	milli	1/1000	1 milligram	0.001 g	1 mg	yes - science and medicine	
	centi	1/100	1 centigram	0.01 g	1 cg	avoid	
	deci	1/10	1 decigram	0.1 g	1 dg	avoid	
(3) GRAM			1 gram	1 g	1 g	yes	0.35 ounce
	deka	10	1 dekagram	10 g	1 dag	avoid	
	hecto	100	1 hectogram	100 g	1 hg	avoid	
	kilo	1000	1 kilogram*	1 000 g	1 kg	yes	2.2 pounds

* 1 000 kilograms = 1 metric ton, about 1.1 short tons

All You Will Need to Know About Metric

(For Your Everyday Life)

10

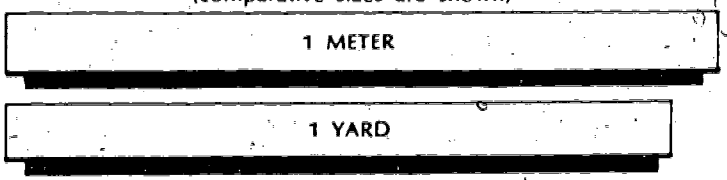
Metric is based on Decimal system

The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar: those for time and electricity are the same as you use now.

BASIC UNITS

METER: a little longer than a yard (about 1.1 yards)
LITER: a little larger than a quart (about 1.06 quarts)
GRAM: about the weight of a paper clip

(comparative sizes are shown)



-25 DEGREES FAHRENHEIT

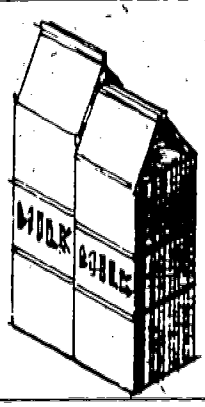
25 DEGREES CELSIUS

COMMON PREFIXES
(to be used with basic units)

Milli: one-thousandth (0.001)
Centi: one-hundredth (0.01)
Kilo: one-thousand times (1000)

For example:
1000 millimeters = 1 meter
100 centimeters = 1 meter
1000 meters = 1 kilometer

1 LITER



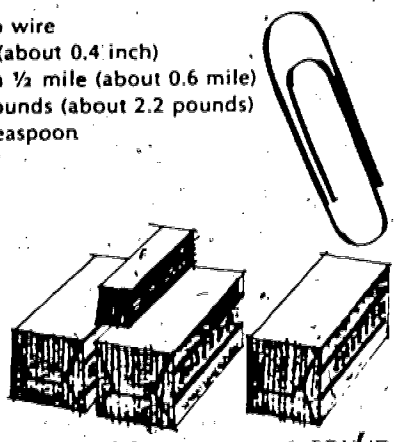
1 QUART

OTHER COMMONLY USED UNITS

Millimeter:	0.001 meter	diameter of paper clip wire
Centimeter:	0.01 meter	width of a paper clip (about 0.4 inch)
Kilometer:	1000 meters	somewhat further than ½ mile (about 0.6 mile)
Kilogram:	1000 grams	a little more than 2 pounds (about 2.2 pounds)
Milliliter:	0.001 liter	five of them make a teaspoon

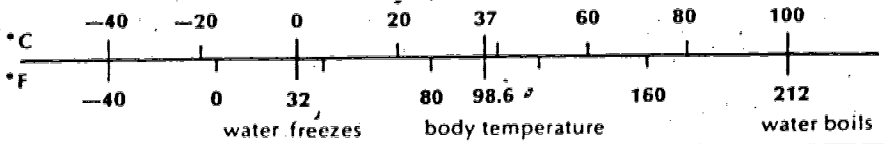
OTHER USEFUL UNITS

Hectare: about 2½ acres
Tonne: about one ton



1 KILOGRAM 1 POUND

TEMPERATURE
degrees Celsius are used



For more information, write to: Metric Information Office, National Bureau of Standards
Washington, D.C. 20234

or: Winston-Salem/Forsyth Metric Education Project
ESEA Title III, P.O. Box 2513, Winston-Salem, N.C. 27102

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