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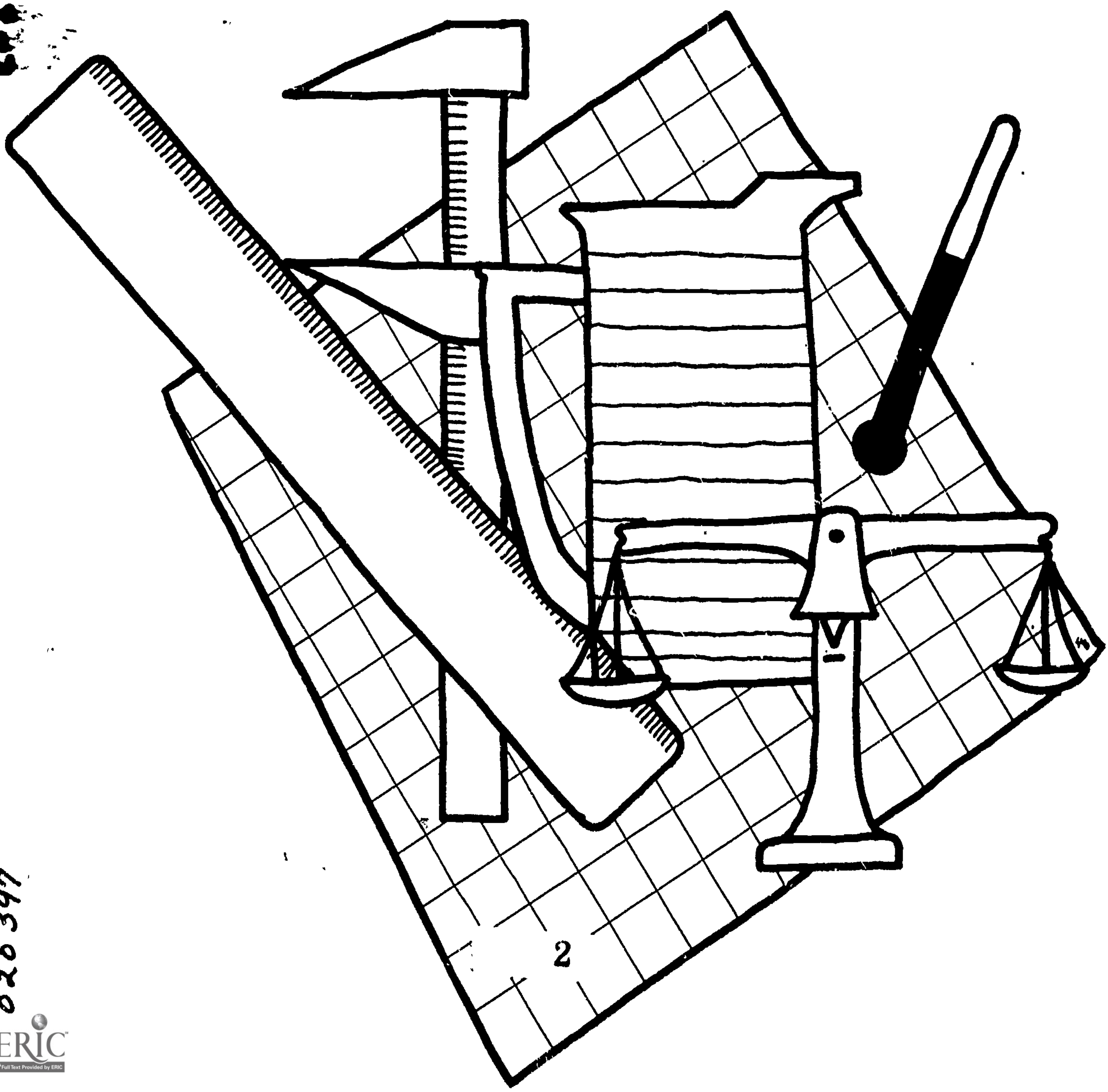
ABSTRACT

This booklet provides the teacher with an overview of the development and use of the metric system, a set of rules and definitions of metric terms, a series of suggested activities related to the metric system, guidelines for conducting metric workshops, and a list of potential sources of resource materials. Measurement pre- and posttests are also included. Many of the activities described are appropriate for students at all grade levels. The tests are designed for secondary students. (SD)

INTRODUCTION TO METRIC MEASUREMENT



INTRODUCTION TO

METRIC MEASUREMENT

A GUIDE FOR INSTRUCTION OF MEASUREMENT TECHNIQUES IN THE INTERNATIONAL METRIC SYSTEM OF MEASUREMENT

Developed by the Delaware State Department of Public Instruction, in cooperation with the Del-Mod System, for the Five State Consortium on Metric Education and partially funded under provisions of Title V-A, Section 505 of the Elementary and Secondary Education Act of 1965.

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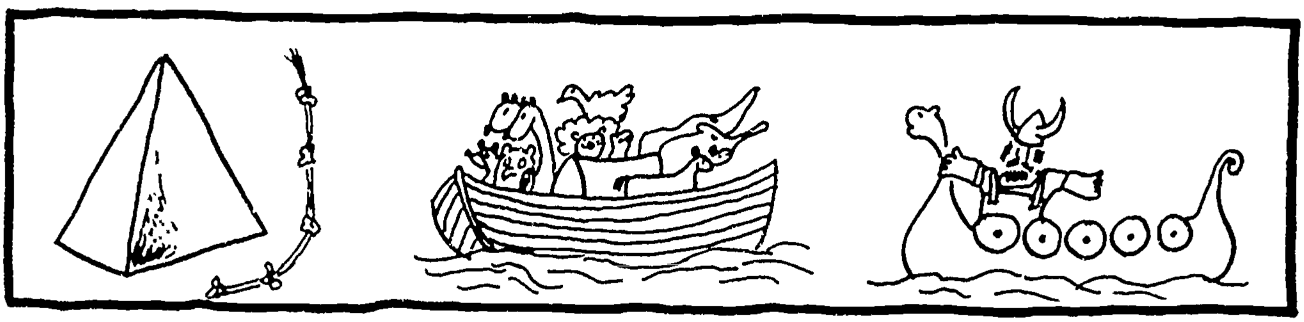
Introduction To Measurement Systems

Man has often attempted to understand and explain what he observes in his surroundings. Our observation leads us to ask not only why, how, or what, but also to consider another type of question: How long is it? How heavy is it? How hot is it? How fast is it moving?

Through the senses you may be able to make rough guesses about such things as size, weight, temperature, and speed. But unless you compare your observations with something that is familiar to others, you cannot describe its characteristics in a way that is familiar to others, you cannot describe its characteristics in a way that has meaning. Accurate observations and the communication of them to others require some standards of measuring.

Measurement is a process of associating with some feature from the natural world a number that describes this feature in terms of some unit. The process of measurement assigns a number to some physical attribute of an object, such as length, volume, mass, or time. Measurements are quantified descriptions.

Some system of counting was necessary before man could develop a system of measurement. We do not know when he learned to count, but it is reasonable to assume that early man at least had the ability to keep track of things by number sense.



Perhaps he measured distance with steps or paces, and long distances by keeping count of the sun rises. Eventually, by using the most convenient object in his environment, man developed a measurement system.

In earliest time man was, quite literally, the measure of all things or at least parts of him were. Some of the units used were the following:

Cubit: The distance from the point of the elbow to the tip of the middle finger.

Span: The distance from the tip of the thumb to the tip of the little finger when the fingers were spread out.

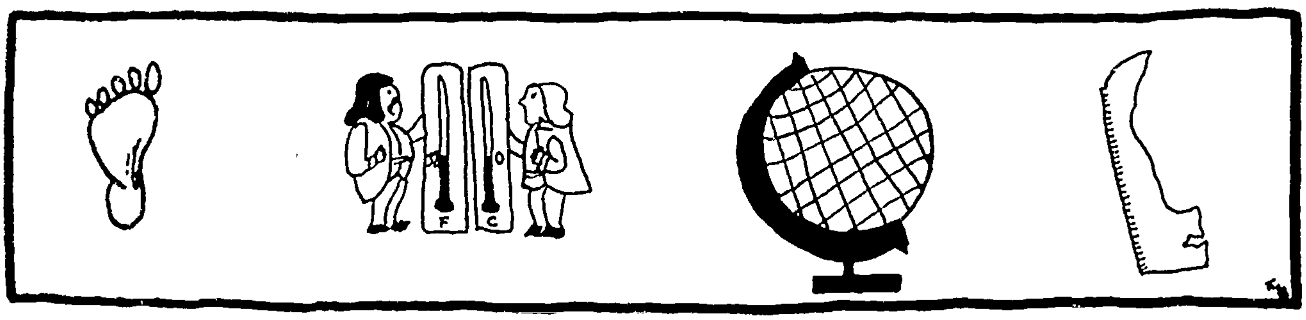
Palm: The breadth of four fingers held together.

Digit: The breadth of the index finger or middle finger.

It is easy to see how the foot was derived, but like other body measurements, it varied from one man to another. In Western Europe, local lords and barons came into power, and the strongest among them became kings. These monarchs set their own standards of measure. They still used body measurements, often the king's personal measurements. King Henry I of England (1068-1135) defined the yard as the distance from the tip of his nose to the end of his thumb when his arm was fully extended to one side.

At the same time, a system of mass (weight) was developed with stones and crude balances. There was no effort to establish a relationship between linear and mass measurements. As the need developed, different units of measurement were standardized such as the furlong, rod, short ton, long ton, and others. This haphazard development of a measurement system created the need for a well ordered, interrelated network of weights and measures called the *metric system.*

Against the tangle of haphazard units, the metric system seems elegantly simple in its consistency. Most of the units it employs are related to powers of ten. A consistent system of prefixes designates multiples and subdivisions of the basic units. The measures are interrelated.



The idea of a system of measurement based on units of ten is by no means a new one. Various proposals have been made during the centuries since man adopted the decimal system of numeration. When the United States was being formed, for instance, Thomas Jefferson devised and proposed a decimal system of measurement, realizing that communication between and among the states could be facilitated by wiping out the profusion of measures then in use. But Americans rejected the system; it seemed "unnatural". A logically developed system could not compete with one that had evolved from the well-springs of history. Besides, some people were, and are, negative simply because the system was developed in foreign countries. The United States continued to reject a decimalized metric system until it became clear (with the metrication of Great Britain beginning in 1965) that it would soon be the only industrial nation in the world using a nonmetric system. The hope that other nations would adopt our system has faded, and we can no longer afford to cling to it.

The path to world wide acceptance of a metric system has not been smooth, but there has been a pattern of continuous progress toward the development and use of an efficient system. The chart that follows traces this pattern and the counterpoint of actions in the United States.

Historical Steps Toward Metrication

1670 Gabriel Mouton (a Lyons vicar generally regarded as the founder of the metric system) proposed a decimal system of weights and measures, definings its basic unit of length as a fraction of the length of a great circle such as the earth.

1740 Preliminary calculations were made with a revisional form of a metre.*

1790 A metric system of measurement was developed by the French Academy. *The need for a uniform system of weights and measures was noted and discussed in the United States Congress, but no action was taken.*

1795 France officially adopted a decimal system of measurement.

1798 A meeting was held in Paris to disseminate information about the mtric system.

1799 The provisional metre and kilogram were replaced by newly established standards.

1821 *A document was issued by John Quincy Adams exhaustively listing the advantages and disadvantages of both the English and the metric systems; Adams concluded that "the time was not right".*

1840 France made use of the metric system compulsory.

1866 *Legislation made it "lawful throughout the United States to employ the weights and measures of the metric system." The system was not made mandatory although this was anticipated.*

1875 The "Treaty of the Metre", setting up well-defined metric standards for length and mass, was signed in Paris by seventeen nations, *including the United States.* The International Bureau of Weights and Measures was established.

1880 Most of Europe and South America had gone metric.

1890 *The United States received prototype metres and kilograms.*

1893 *The metric prototypes were declared by the Superintendent of Weights and Measures to be the "fundamental" standards" for the United States; other measures were defined in terms of the standard metre and kilogram.*

1918-29 *Approximately forty bills on metrication were introduced into Congress but no action was taken.*

1959 *Customary units were officially defined in terms of metric units.*

1960 The metre was redefined in terms of wavelength of light. The modernized metric system, the International System of Units (Systeme International d' Unites), referred to as SI, was established.

1965 Great Britain announced its intention to convert to the metric system.

1968 *The United States Congress directed the Secretary of Commerce to undertake the three year United States Metric Study, to evaluate the impact of the metric trend, and to consider alternatives for national policy.*

1971 *As a result of the Metric Study, it was recommended that the United States change to predominant use of the metric system through a coordinated national program.*

*The spelling of "meter" and "liter" has not been officially decided. Many people advocate the use of "metre" in accordance with international standards.

1972 *The Metric Conversion Act was passed by the Senate, but no action was taken by the House of Representatives. [This means that new action will be required by Congress.]*

1974 On May 7 the United States House of Representatives defeated a motion to suspend the rules to consider metric conversion legislation without any amendments being attached. (While metric legislation is not dead, indications are that no further action will be taken during the remainder of the 93rd Congress.)

GRAINS OF WHEAT MEASURED MASS

Why Metric?

On February 21, 1974 the State Board of Education passed the following resolution.

BE IT RESOLVED that the State Board of Education adopts as policy the conversion of all measurement language to the International Metric System of Measurement in all phases of public education in Delaware not later than the year 1980; and it further

RESOLVED that commencing with the 1976 - 77 school year, and thereafter, all schools subject to the rules and regulations of the State Board of Education shall provide instruction in the International Metric System of Measurement. Such instruction may be in addition to present instruction concerning the system of weights and measures in the public schools on the effective date of this resolution; provided, however, that the International Metric System of Weights and Measures shall be taught exclusively as the primary system of measurement beginning with the 1980 - 81 school year.

This resolution is apparently the culmination of a three to four year long series of events.

The present national concern for metrication historically dates back to 1968 when Congress passed a Metric Study Act. This concern appears to stem from three major areas of importance. They are:

1. increased use of the metric system in the United States;
2. the need for an international standard; and
3. simplicity of the metric system as compared to the present system of weight and measures.

Increased Use of Metric

Within the last few years many prominent industrial organizations have announced a commitment to change over to metric measurement in their operations. Approximately 11 percent of American manufacturing companies already use the metric system to some degree. Pharmaceuticals and chemicals, the optics industry, microfilm industry, and some divisions of aircraft and automobile companies, among many others, now employ metric measurements. And the housewife has probably noticed that food labeling often includes grams as well as ounces on packages and cans.

The American National Standards Institute recently formed the American National Metric Council to help guide the change to metric for the industrial and commercial segments of our society. In addition, many key associations have adopted pro-metric resolutions. These cover a wide range of interests, and include the National Association of Manufacturers, the United States Chamber of Commerce, the National Education Association, the American Home Economics Association, and the National Grange.

Metrication is receiving much attention in the press. The nation's newspapers have carried an average of four to five articles on this subject since the United States Metric Study report was sent to the Congress in 1971. In this same period of time, nearly every paper has carried a metric editorial with interesting results: 91 percent were pro-metric; 7 percent were neutral; and only 2 percent were anti-metric.

Road signs giving distances and/or speed limits in both metric and customary units are appearing in several states. Perhaps the most notable is in Ohio, where their State Department of Transportation, as part of a program to introduce metric into their operations, began to erect dual marked distance signs early in 1973. Other states reported to have some such signs include Arizona, Maryland, Minnesota, Washington, Virginia, Michigan, and Pennsylvania.

The National Park Service, beginning in 1974, will add metric values to park signs and pamphlets for the benefit of the United States citizens as well as foreign visitors.

The Departments of Agriculture, Defense, and Health, Education, and Welfare have already employed the metric system in many activities. For example, the Department of Agriculture began using the metric system of measurement in its regular crop reports effective May 9, 1974.

In August, 1972 the Senate unanimously approved a bill to make the metric system predominant within ten years. The House of Representatives did not take action on this bill which forced the initiation of new legislation. Presently, there are bills before the House of Representatives and the Senate. While these bills may not be passed this year, probably in the near future the United States Congress will enact legislation that will commit this country to metrication.

Need for International Standard

The primary reasons for the increasing use of metrics by our industries, which finds it necessary to change to international metric standards, are two fold. First, as an aide to maintaining and expanding our exports and secondly, as a means of avoiding the inefficiency and inconvenience of operations at home and abroad where they are manufacturing the same products to different standards.

The change to metric units of measurement is inevitable. Over 90 percent of the earth's population now lives in countries committed to the use of the metric system of measurement. In 1970 only the United States and a few small countries were not part of the metric world.

England, where our present system of units originated, has gone metric. Our neighbor to the north, Canada, is now in the midst of converting totally to the use of the metric system. The hope that our system would be adopted by other nations has faded and we can no longer afford to cling to it.

The Metric System is Simple

That the metric system is as much simpler than the one currently being used in the United States is a fact.

Present nationwide metric publicity and promotion of the international metric system is confusing the the public, however, and will retard acceptance of metric in America.

First, there are seven base units. They are the metre, kilogram, second, degree Kelvin, ampere, candela, and the mole. Of these only three will be of major concern to the public, the metre, base unit of length; the kilogram, base unit of mass; and degrees Kelvin, the base unit of temperature. The common unit for volume and capacity will be the litre.

Although the degree Kelvin has been chosen as the basic unit of temperature, the degree Celsius will receive more common acceptance. These two scales are "identical" with exception of the zero reference points.

There are fourteen prefixes accepted as part of the International Metric System. Of these, only three will be of common concern to the general public. There are: kilo, centi, and milli.

There's another nice thing about the metric system everyone will appreciate. Since it is based on the decimal system, there are no fractions to contend with. You don't have to know fractions to handle money because the money is decimalized. You don't talk about one and four twenty-fifths dollars, you pay one dollar and sixteen cents. The same is true of the metric system.

When India changed to the metric system in 1956, they found that even the people who couldn't read or write had no trouble learning the new system. Therefore, the metric system should be no problem for you.

In the conversion to the metric system, the greatest disadvantage for Americans would be in *acceptance of the changeover -- not in learning the system itself.*

In researching the problems of metric transition, we have never found, in a single simple book, data that would quickly update teaching personnel in the general principles involved.

Herein, we outline data we feel is urgently needed for use in the educational system.

Because metric -- SI -- is still evolving, disagreement may be taken with some of our findings; however, at this stage it would not be improbable that this would not be the case.

With the United States' adoption of the metric system and the International System of Units (SI for short) this nation will be harmonizing its practices with the balance of the industrialized world.

This section outlines the basics of the new system in sufficient depth for updating personnel purely on the basis of limited study. Future personnel will undoubtedly be educated solely in metric terms and textbooks updated accordingly; however, a critical need exists for a publication for immediate use during the early stages of United States transition; thus this guide.

It explains the system and presents a list in ready-reference format of the recommended units.

Base Units and Supplementary Units

The modernized form of the metric system of units is known as the International System of Units (Systeme International d' Unites) adopted by the General Conference of Weights and Measures (CGPM) and sanctioned by the International Standards Organization (ISO).

The short symbol for the system is "SI".

The SI uses seven base units and two supplementary units. The units are:

ITEM	NAME OF UNIT	SYMBOL
BASE UNITS		
LENGTH	METRE	m
MASS	KILOGRAM	kg
TIME	SECOND	s
ELECTRIC CURRENT	AMPHERE	A
TEMPERATURE	KELVIN	K
LUMINOUS INTENSITY	CANDELA	cd
AMOUNT OF SUBSTANCE	MOLE	mol
SUPPLEMENTARY UNITS		
PLANE ANGLE	RADIAN	rad
SOLID ANGLE	STERADIAN	st

Prefixes - pronunciation & meanings

The common prefix listing was at one time greater in number than the fourteen now recognized in ISO STANDARD 1000; these prefixes are ample enough to cover all general consumer needs as well as the technical requirements of industry and research.

The prefixes are presented here by name spelling, symbol reference, diacritical marking, exponent form, decimal form, and descriptor respectively -- the order of presentation diminishes from largest multiple toward base unit one and then on to the smallest sub-multiple prefix.

1.	tera	T	tĕr'ȧ	10^{12}	1 000 000 000 000	one trillion times
2.	giga	G	ji'gȧ	10^{9}	1 000 000 000	one billion times
3.	mega	M	mĕg'ȧ	10^{6}	1 000 000	one million times
4.	kilo	k	kĭl'ō	10^{3}	1 000	one thousand times
5.	hecto	h	hĕk'tō	10^{2}	100	one hundred times
6.	deca	da	dĕk'ȧ	10^{1}	10	ten times
7.	deci	d	dĕs'ĭ	10^{-1}	0.1	one tenth of
8.	centi	c	sĕn'tĭ	10^{-2}	0.01	one hundredth of
9.	milli	m	mĭl'ĭ	10^{-3}	0.001	one thousandth of
10.	micro	u	mī'krō	10^{-6}	0.000 001	one millionth of
11.	nano	n	năn'o	10^{-9}	0.000 000 001	one billionth of
12.	pico	p	pē'kō	10^{-12}	0.000 000 000 001	one trillionth of
13.	femto	f	fĕm'tō	10^{-15}	0.000 000 000 000 001	one quadrillionth of
14.	atto	a	ăt'tō	10^{-18}	0.000 000 000 000 000 001	one quintillionth of

This prefix listing provides a convenience of choice for the appropriate multiple of the SI base supplementary/derived unit so as to lead the numeral value to within a practical utility range. Generally a multiple would be selected in such a manner as to allow the numerical value to be somewhere between 1 000 and 0.1 (for example, 3.94 mm as opposed to 0.003 94 m, or 12 kN as opposed to 1.2 X 10 4 N, or, 0.1 Mm or 100 km as opposed to 100 000 m, or 1,4 kPa as opposed to 1 400 Pa, and so forth).

The Use of Prefixes in the Metric System

In the metric system the value of the common unit is changed by simply placing a prefix in front of it. With the three common units. metre, litre, and gram, the prefixes: "kilo", "hecto", "deca", "deci", "centi", "milli", etc. will change the quantity of the basic unit.

The relationship of these quantities is very simple once these basic units and assigned prefixes have become familiar. Some prefixes are used more commonly than others. Usually, multiples of 1 000 of the basic unit are preferred.

Illustrated Use of Prefixes

Greek prefixes	*kilo*	(thousands 10^3)
	hecto	(hundreds 10^2)
	deca	(tens 10^1)
BASIC UNIT no prefix		(one 1)
Latin prefixes	*deci*	(tenths 10^{-1})
	centi	(hundredths 10^{-2})
	milli	(thousandths 10^{-3})

Note: All the prefixes have not been shown here.

kilolitre	not commonly used
hectolitre	not commonly used
decalitre	not commonly used
LITRE	
decilitre	not commonly used
centilitre	not commonly used
millilitre	(0.001 litres)

kilometre	(1 000 metres)
hectometre	not commonly used
decametre	not commonly used
METRE	
decimetre	not commonly used
centimetre	(0.01 metres)
millimetre	(0.001 metres)

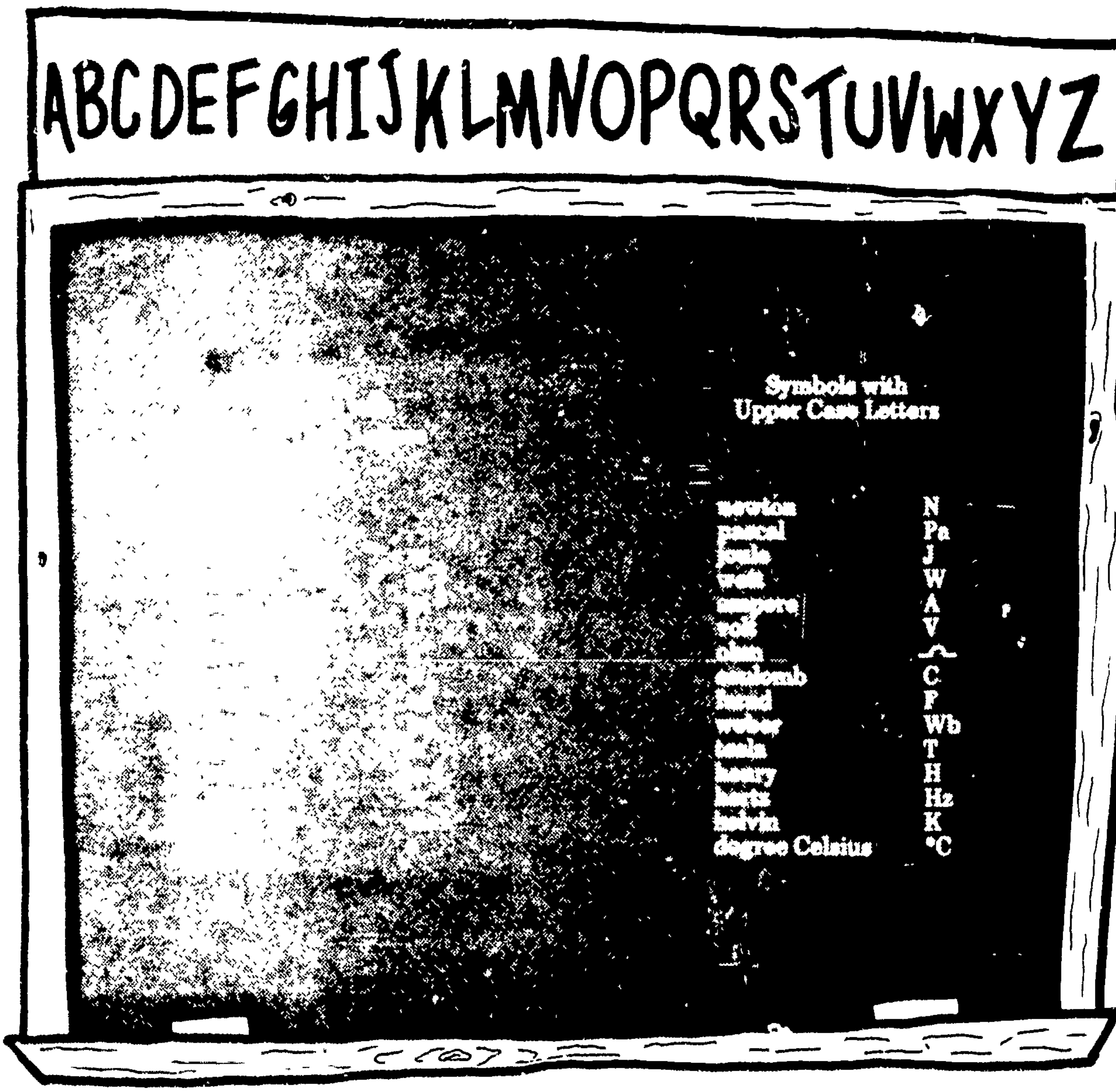
GRAM

kilogram	(1 000 grams)	decigram	not commonly used
hectogram	not commonly used	centigram	not commonly used
decagram	not commonly used	*milligram*	(0.001 grams)

Note:
In the SI system the gram unit of mass proved to be too small for practical applications, therefore, the kilogram has been officially designated as the standard unit for mass.

S I Symbols

With minor modifications these symbols are in accordance with the recommendations of the International Organization for Standardization (ISO).



Rules For The Use Of The International Metric System

Only one prefix can be used at a time. Compound prefixes are incorrect.

The *plural -s* is *never* used with metric symbols.

Metric symbols are always written *without a period.* Symbols may be raised to a power, but abbreviations followed by a period can not.

Square and cubic measure Units of area and volume must be written with an exponent 2 and 3 respectively: m^2, km^2, m^3, cm^3 (cc is incorrect).

Litre.. An ordinary lower case "l" could, in some contexts, be mistaken for the figure 1; therefore, the symbol should preferably be written in italics, cursive, or else the word litre written out.

Whenever practical, *decimals* should be used instead of fractions: 0.75 instead of 3/4. Decimals are also preferred for computer application, as common fractions introduce complication in keypunching and programming.

There must always be a *space* between the numerical value and the symbol of the unit.

The *thousands marker.* Groups of three digits above and below the decimal marker should be separated by a small space (a full space in typing and one-half space in printing). The comma, which has traditionally been used for this purpose, is discouraged, in order to avoid confusion with the predominant practice in metric countries of using a comma instead of a decimal point.

If a numerical value is less than 1 (one) a zero must precede the decimal marker. 0.5 instead of .5.

Temperatures. The degree symbol ° is necessary with Celsius (°C), in order to distinguish it from coulomb (C). But kelvin has no degree symbol. Although kelvin is the basic SI unit for (absolute) temperature, Celsius is the internationally current unit of temperature preferred for most practical applications. (For temperature interval. 1K = 1°C). While it was, in English and French, at one time called "centigrade", Celsius is since 1948 the only official term in most countries, including Canada and the United States.

Symbols of units named after historic persons are written with upper case initials, all other symbols are lower case.

Prefixes. Only the symbols of the three highest prefixes "tera", "giga", and "mega" are written with upper case letters. All other prefixes must be lower case.

The preposition "per" indicating ration or the function division should, in SI symbols, preferably be written with an oblique stroke or solidus /. Speed: m/s; electric field strength: V/m.

Metric Definitions and Derived Units

The *metre*, the basic unit of length in the metric system, is defined as 1 650 763.73 wave lengths in vacuum of the orange-red line of the spectrum of krypton 86.

Derived units:

Area - square metre

- hectare (10 000 square metres)

Volume and capacity - cubic metre

- litre

Because the gram is rather small, the *kilogram* has become the standard unit of mass in the metric system. The standard kilogram is based on a cylinder of platinum-iridium alloy kept by the International Bureau of Weights and Measures in Paris.

Derived units:

Force - 1 *newton* applied to a mass of 1 kilogram gives an acceleration of 1 metre/second squared.

Work or Energy - the force of 1 newton applied through a distance of 1 metre produces 1 *joule* of work done.

Power - 1 joule of work done in 1 second is 1 *watt* of power.

Pressure - 1 newton of force applied to an area of 1 square metre is 1 *pascal.*

The second, the basic unit of time in the metric system, is defined as the duration of 9 192 631 770 cycles of the radiation associated with a specified transition of the cesium atom.

Derived units:

Frequency - a frequency of one period (cycle) per second is called 1 *hertz.*

Speed or Velocity - metre/second.

Acceleration - metre/second/second.

The *candela* is the basic unit of luminous intensity in the metric system. It is defined as the intensity of 1/600,000th of a square metre of the cone of light emitted by a black body that has been heated to 2 042 Kelvins, the freezing point of platinum.

Derived Units:

Illumination - *lux.*

Luminous flux - *lumen*

The *mole* is the standard metric unit for the amount of a particular substance. It is defined as the amount of substance in a system that contains as many elementary entities as there are atoms in 0.012 kilograms of carbon 12. Moles are primarily used in physics and chemistry when discussing such things as atoms and molecules.

The *Kelvin* scale is used to measure temperature in the metric system. The Kelvin scale has its origin, or zero point, at absolute zero (the point at which all atomic vibration ceases) and a fixed point (273.16 Kelvins) at the triple point of water -0° Celsius (the temperature at which water exists in all three states - vapor, liquid, and solid). The Celsius scale is derived from the Kelvin scale and has 0° for the freezing of water and 100° as the boiling point.

The *ampere* is the basic unit of electric current in the metric system. It is determined by passing current through two parallel wires separated by a distance of one metre and then measuring the force of attraction between the wires, caused by their magnetic fields. The ampere is defined as the amount of current that will produce a force of exactly 2 X 10 newtons between the two wires for each metre of length.

Derived Units:

Electric potential - *volt*

Electric resistance - *olm*

Electric capacitance - *farad*

Electric charge - *coulomb*

Electric inductance - *henry*

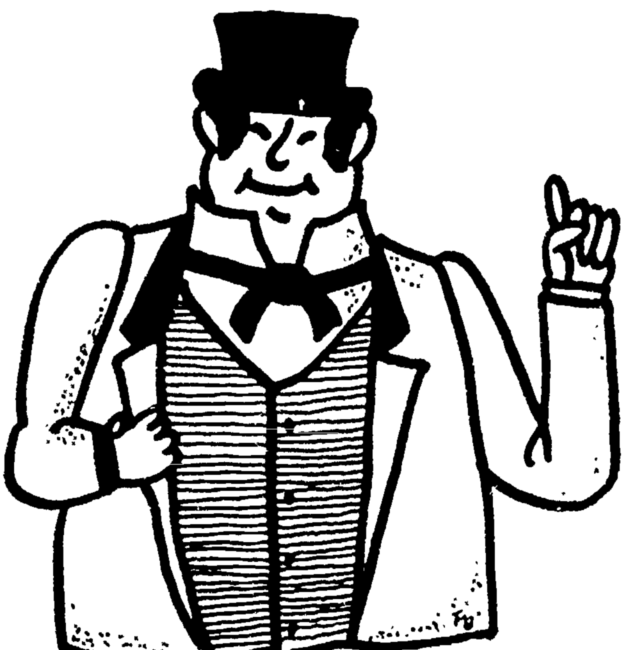
Magnetic flux - *weber*

Magnetic induction - *tesla*

SI Supplementary Units:

Plane angle or *radian*. The unit of measure of a plane angle with its vertex at the center of a circle and subtended by an arc equal in length to the radius.

Solid angle or *steradian*. The unit of measure of a solid angle with its vertex at the center of a sphere and enclosing an area of the spherical surface equal to that of a square with sides equal in length to the radius.



BRITIAN METRIC
1964

U.S. METRIC STUDY
1968

TRY YOUR HAND AT METRIC MATH

1.1 cm	=	______	mm
1.9 cm	=	______	mm
20 mm	=	______	cm
2 m	=	______	mm
2 m	=	______	cm
2.5 m	=	______	mm
5 g	=	______	mg
2 kg	=	______	g
600 mg	=	______	g
700 ml	=	______	l
2 l	=	______	ml
2 m^3	=	______	l

0.001 m	=	______	mm
0.021 m	=	______	mm
0.321 m	=	______	mm
1 cm	=	______	mm
1 cm	=	______	m
12 cm	=	______	m
12 cm	=	______	mm
0.9 m	=	______	cm

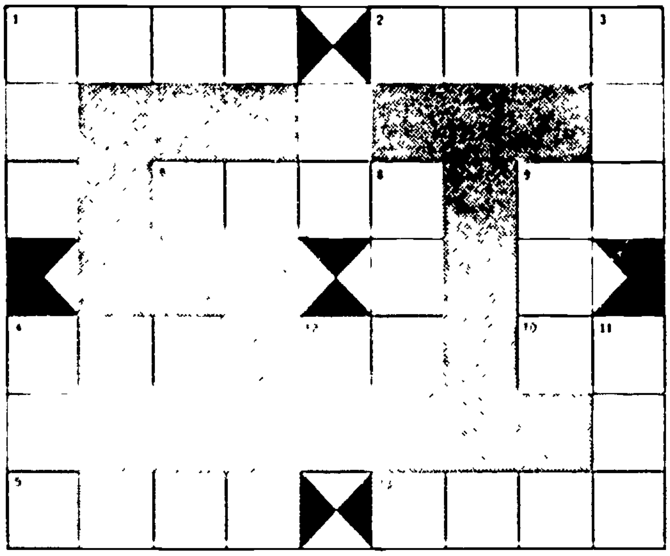
0.001 l	=	______	ml
0.032 l	=	______	cm^3
0.126 l	=	______	ml
0.001 g	=	______	mg
0.052 g	=	______	mg
0.126 g	=	______	mg
1.001 m	=	______	mm
2.002 l	=	______	ml

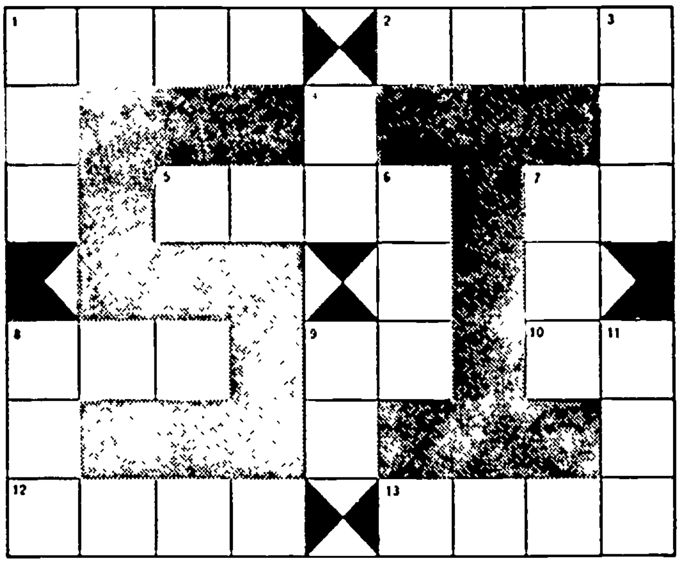
2 mm	=	______	m
5 mm	=	______	m
4 m	=	______	km
3 ml	=	______	l
6 mg	=	______	g
7 g	=	______	kg

54 g	=	______	kg
11 mm	=	______	m
101 cm^3	=	______	l
101 mg	=	______	g
20 mg	=	______	g
16 ml	=	______	l

METRIC CROSSWORDS

Solve like a crossword puzzle except that numbers replace words. Be sure to express answers in the indicated units.





ACROSS

1. 1.5km - 200m = ________ m
2. 4m + 25mm = ________ mm
4. 5hm - 200m = ________ m
5. 300mm x 400mm = ________ cm 2
6. 8.4km - 7.6dam = ________ m
9. 100 dm = ________ m
10. 1 hm - 18 m = ________ m
12. 5m x 90dm = ________ m 2
13. 5,000m x 300km = ________ km 2

DOWN

1. 100mm + 2.5 cm = ________ mm
3. 500 cm + 200mm = ________ cm
4. 30 cm + 0.2dm + 1 mm = ________ mm
7. 22,000mm - 10m = ________ m
8. 0.4km + 0.5hm + 5m = ________ m
9. 48cm + 1,000mm = ________ cm
11. 5,000cm x 4,000mm = ________ m 2
12. 10dm - 600mm = ________ cm

ACROSS

1. 3g + 125mg = ________ mg
2. 2000g - .275kg = ________ g
5. 13.2g - .65 = ________ cg
7. 180g + 200dg = ________ dag
8. 11dg + 13cg = ________ cg
9. 100dg = ________ g
10. 10.22hg - .938kg = ________ g
12. 50dg + 120cg - 2075mg = ________ mg
13. 2.5kg = ________ g

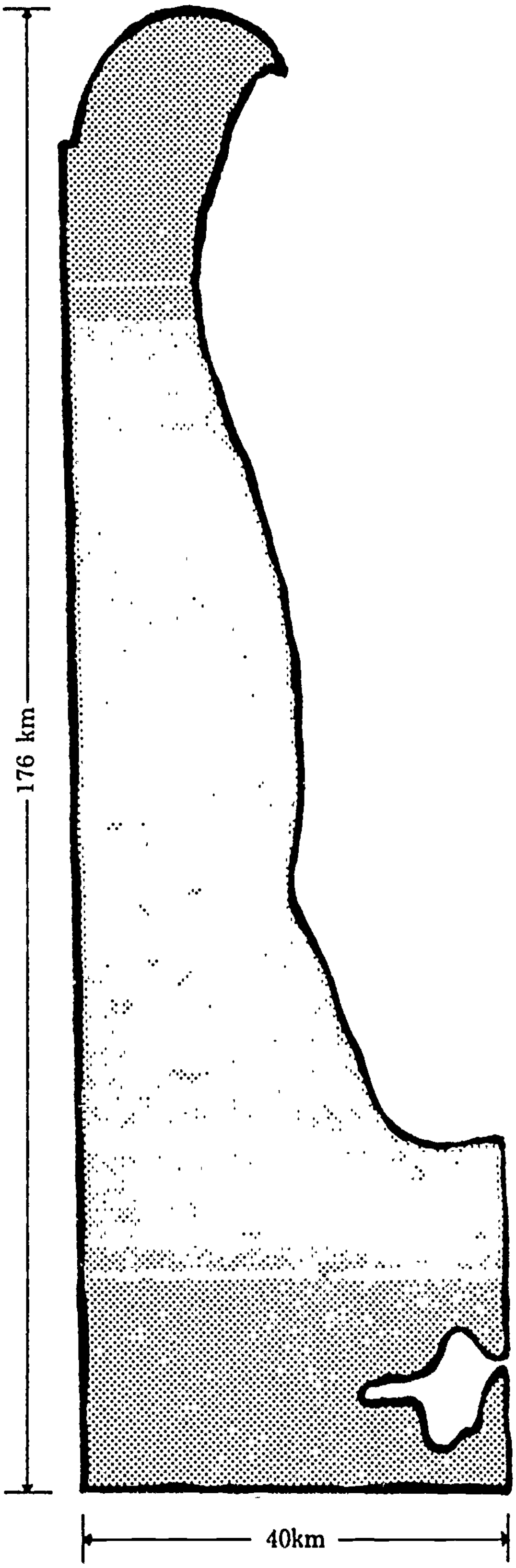
DOWN

1. 55kg - 20kg = ________ hg
3. 60dag - .1kg = ________ g
4. 3.5g + 40dg = ________ dg
6. 510 000g = ________ kg
7. 1.133g - .915g = ________ mg
8. 110 500mg + 3500mg = ________ g
9. 1200cg = ________ g
11. 4.20dg = ________ mg

NOTE: The prefixes hecto (h), deka (da), and deci (d), are not as commonly used as the others in the puzzle, but they are (SI).

Puzzle courtesy University of Missouri - Rolla

MEASUREMENT ACTIVITIES LINEAR



Common Units Used for Length Measurement

millimetre (mm)	Used in measuring very small lengths. Example: postage stamp.
centimetre (cm)	Used in measuring very common lengths. Example: body measurements.
metre (m)	Used in measuring intermediate lengths. Examples: room size, track and field events.
kilometre (km)	Used in measuring long distances. Example: from one town to another.

Relationship of the Metric Units Used for Length Measurement

10 millimetres	=	1 centimetre
100 centimetres	=	1 metre
1 000 metres	=	1 kilometre

Body Facts: How Well Do You Know Yourself?

Materials: metre stick, metric tape measure.
Directions. Find the following body measurements in centimeters. (Make an estimate first, then check your estimation.)

	Estimate	Actual
1. Your height		
2. The length of your foot		
3. The width of your finger		
4. The width of your hand		
5. The distance around your waist		
6. The distance around your wrist		
7. The distance around your neck		
8. The distance around your chest		
9. Your head size		

Metric Treasure Hunt

Materials: x lists of lengths to find
x metre sticks
x sets of letters or pieces of colored construction paper

Directions. Each student or team is given metre sticks and a list of lengths to find. They are turned loose in some pre-designated area (the room). As the lengths are found, it is marked with a specific color of construction paper or a letter. No other team or individual can use that object which contains the length. The first team or student finished wins.

Note. Could also be used for volume, area, mass, etc.

Line Estimation

Materials: cm ruler, paper, pencil

1. Draw lines of the following length by estimation first, then using a ruler, draw the actual length.

10 millimetres	10 centimetres
100 millimetres	0.01 metres
1 centimetre	0.1 metres

2. Measure this line and express its length in:

millimetres ________________ mm
centimetres ________________ cm
metres ________________ m

3. Measure the length of this line and express its length in:

millimetres ________________ mm
centimetres ________________ cm
metres ________________ m

How Long Is It?

Materials: centimetre, ruler, metre stick

Directions: Use your centimetre ruler and a metre stick divided into centimetres to measure the lengths of these things found in the classroom. If the distance that you measure is more than a metre, say 1 metre and 25 centimetres, you can write it as 125 cm or 1.25m.

	Estimate	Actual
desk	________ cm	________ cm ________ m
table	________ cm	________ cm ________ m
large book	________ cm	________ cm ________ m
newspaper	________ cm	________ cm ________ m
radiator	________ cm	________ cm ________ m
blackboard	________ cm	________ cm ________ m
shelves	________ cm	________ cm ________ m
stride	________ cm	________ cm ________ m
stretch	________ cm	________ cm ________ m
span	________ cm	________ cm ________ m
pencil	________ cm	________ cm ________ m
pen	________ cm	________ cm ________ m
door height	________ cm	________ cm ________ m
length of room	________ cm	________ cm ________ m
thickness of a quarter	________ cm	________ cm ________ m

"Foot" Measure

Materials: a metre stick and a piece of chalk

Directions: In the playground mark a starting line and from it take 10 ordinary strides. Mark the distance and guess it to the nearest metre and nearest cm. Do this again with 15 strides, 25 strides, and 40 strides. Mark off 5 heel and toe foot-lengths. Guess the distance to the nearest cm. Mark off and guess the length of 3 foot lengths, 8 foot lengths.

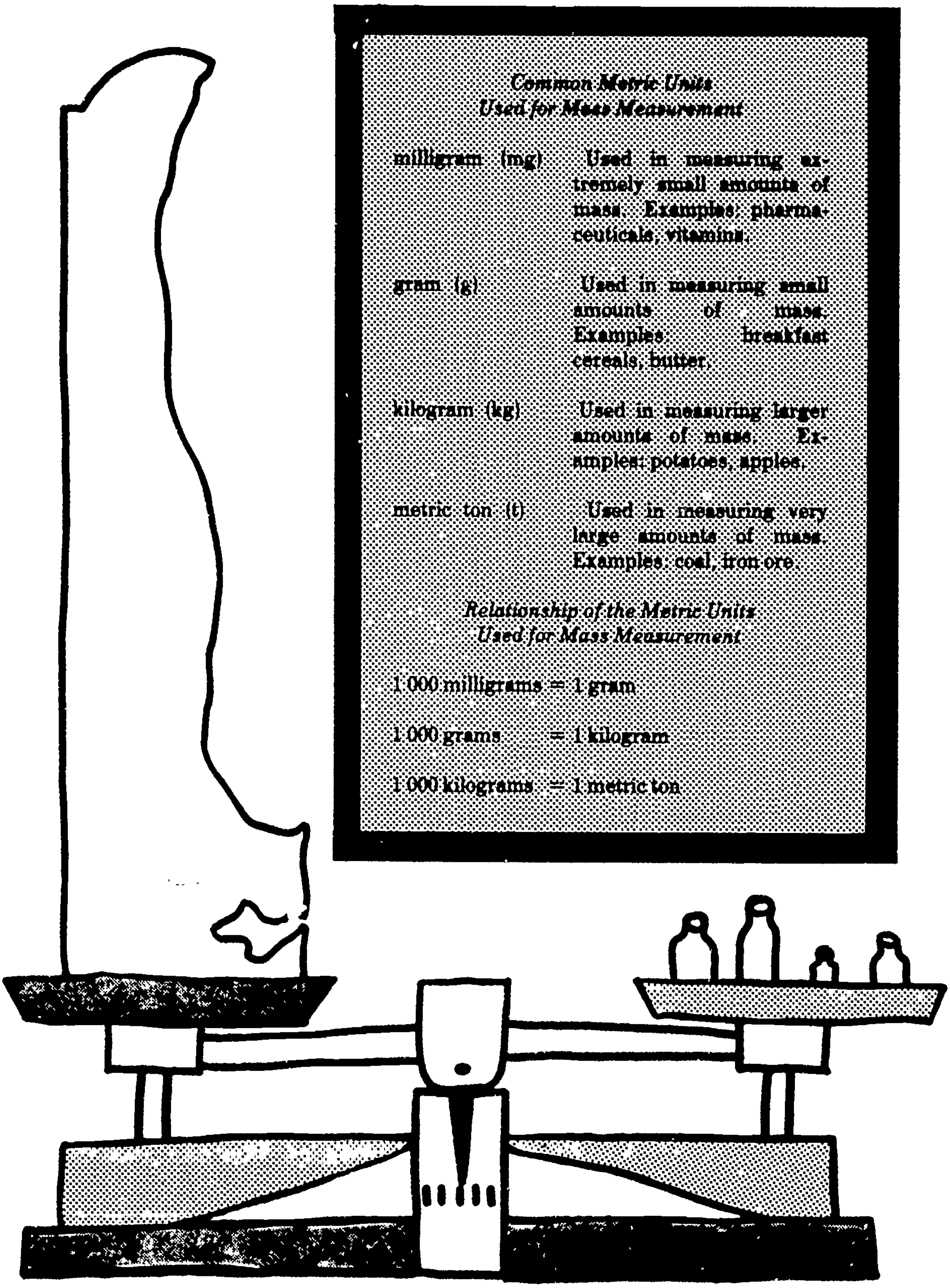
How High?

Materials: 2-metre stick

Directions: You can use a 2-metre stick to guess the height of tall things like trees and buildings. Your partner holds the 2-metre stick upright by the tree and you stand about 50m from the tree. Hold a pencil at arms length so that the distance from the point of the pencil to your thumb is the same as the height of the two-metre stick. Still holding the pencil at arm's length count how many pencil point to thumb lengths there are in the tree.

MEASUREMENT ACTIVITIES

MASS



Common Metric Units
Used for Mass Measurement

milligram (mg)	Used in measuring extremely small amounts of mass. Examples: pharmaceuticals, vitamins.
gram (g)	Used in measuring small amounts of mass. Examples: breakfast cereals, butter.
kilogram (kg)	Used in measuring larger amounts of mass. Examples: potatoes, apples.
metric ton (t)	Used in measuring very large amounts of mass. Examples: coal, iron ore.

Relationship of the Metric Units
Used for Mass Measurement

1 000 milligrams	= 1 gram
1 000 grams	= 1 kilogram
1 000 kilograms	= 1 metric ton

Mass Measurement

This section includes the measurement of quantity of material or the measurement of mass. Mass, which remains the same anywhere in the universe, is measured in units of milligrams, grams, kilograms, and metric tons.

In everyday life, mass and weight are often used interchangeably. Weight is the measurement of the gravitational force on an object and varies with location in the universe. Weight is measured in Newtons.

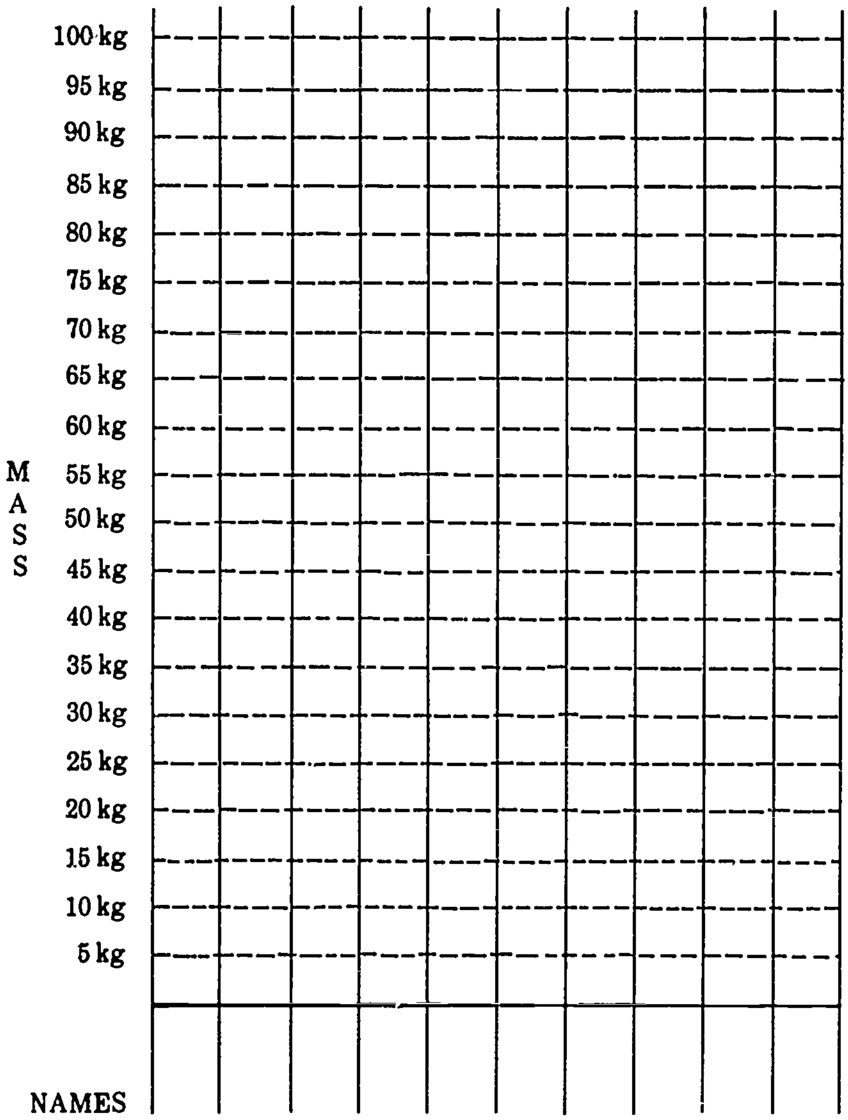
To illustrate the above a one kilogram mass on the earth's surface is acted upon by a gravitational force of approximately 9.8 Newtons. The same kilogram mass on the moon's surface is acted upon by a gravitational force of approximately 1.6 Newtons.

The following example distinguishes between mass and weight. One kilogram of potatoes measured by mass (balance scale) would be exactly the same quantity of potatoes either on the earth's surface or on the moon's surface. Similarly, 9.8 Newtons of potatoes measured by weight (spring scale) would be one kilogram mass on the earth's surface, however, it would be approximately six kilograms on the moon's surface.

How to Lose Pounds Without Dieting

Materials: bathroom scale (metric)

Directions. Estimate your mass. Find your mass on the metric scale. Put your name on the chart and color up to your mass. Then find 9 friends, measure their masses, and record them on the chart.



How Heavy Is It?

Materials: metric weights, pan & balance

Directions: Pick up various metric weights and estimate the number of grams of each. What is the actual weight?

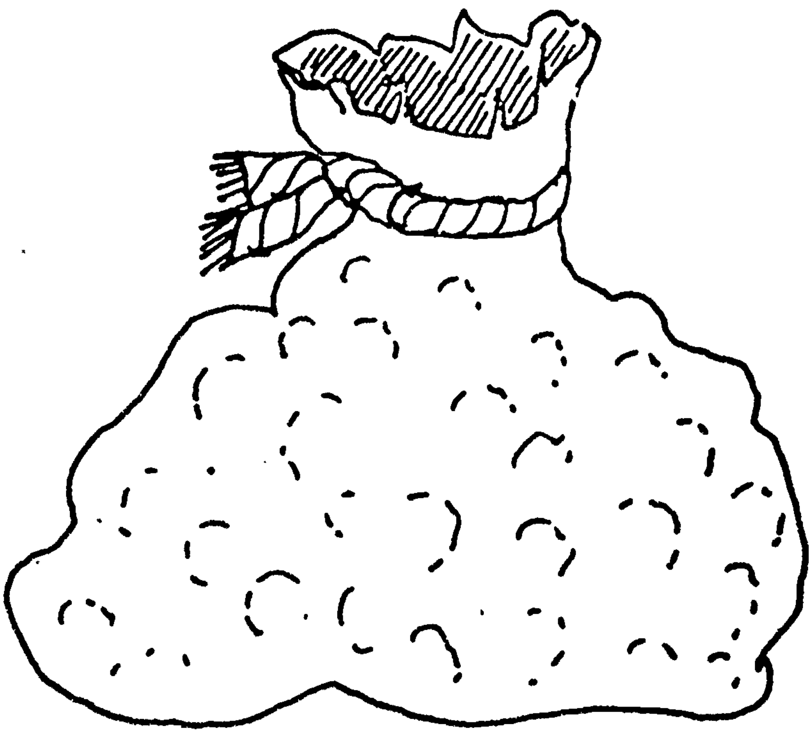
Rank the following materials from lightest to heaviest. Weigh the following materials on the pan balance.

rock	white cuisenaire rods
cup	marble
4 nickels	pan balance
can of beans	wheat
grain of corn	plastic measuring cups and/or containers
large book	salt
potato	

Try to find something that weighs: Record it

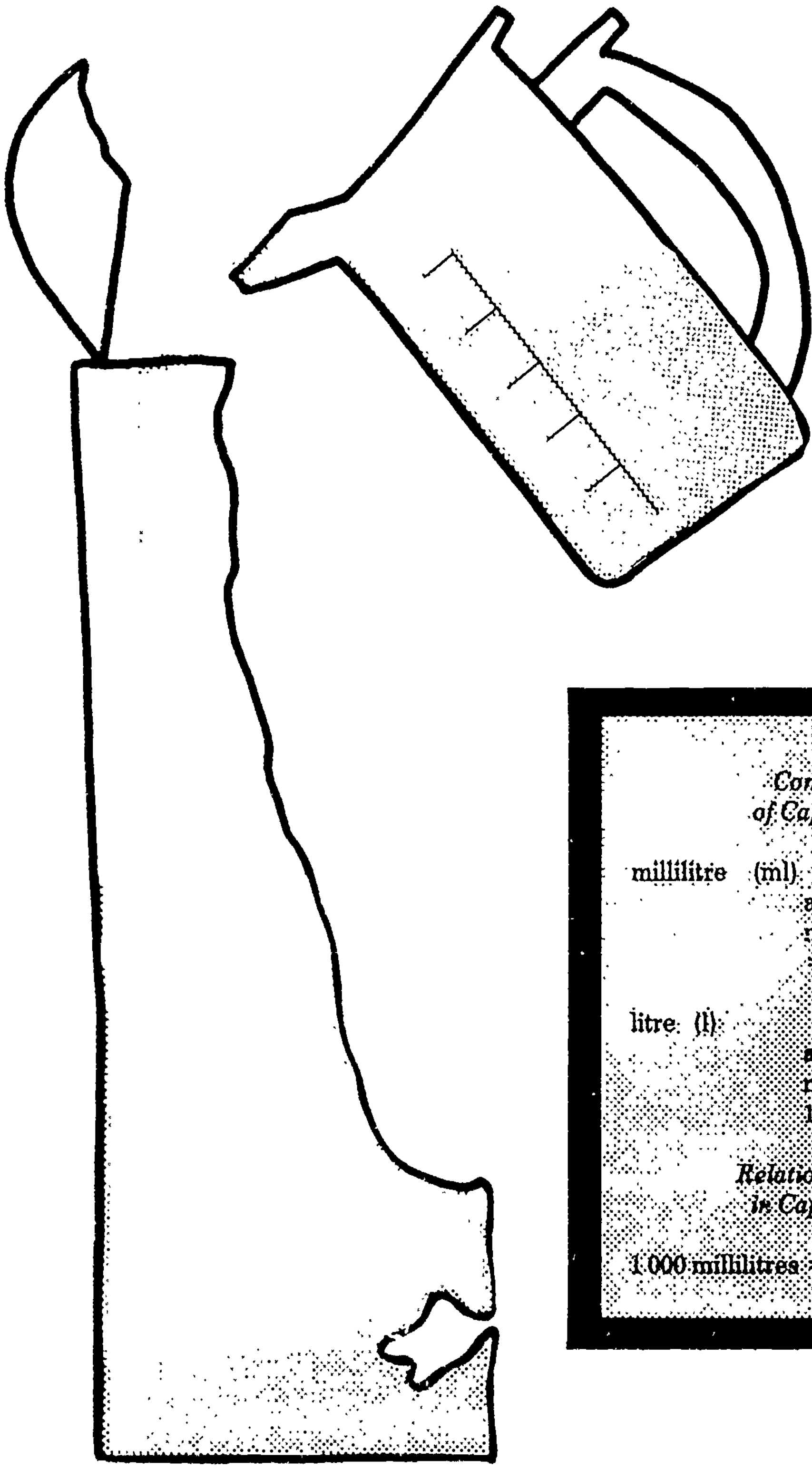
one g ____________________
ten g ____________________
50 g ____________________
200 g ____________________

How Much Are You Worth?



If you had a bag full of pennies which weighed the same as you, how much would they be worth. What equipment would you need to find this out? Tell what you would do to find out. Do it.

MEASUREMENT ACTIVITIES
CAPACITY



Common Metric Units of Capacity Measurement

millilitre (ml) Used in measuring small amounts of liquids. Examples: medications, soft drinks. (1 ml = 1 cm 3)

litre (l) Used in measuring common amounts of liquids. Examples: milk, gasoline, paint. (1 litre = 1 000cm 3)

Relationship of Metric Units in Capacity Measurement

1 000 millilitres = 1 litre

Capacity Measurement - What Is A Litre?

Materials needed: cardboard, tape, metric ruler

Directions: Make a box out of the cardboard that is 1 decimetre by 1 decimetre. We call the capacity of this box one litre. We often use it to measure liquids. Save your box for future activities.

Guessing Capacity

Materials needed: 6 different shaped containers, beans

Directions: Guess which holds the most? Which holds the least? Sort them by guess from least to greatest volume. How can you find out if your guess is correct? Would beans help? Would water help? Think of a plan. Find out if your guesses were correct.

Capacity Comparison

Materials needed. materials from preceeding activity, standard metric capacity containers, box from first activity.

Directions. Estimate the capacity in litres of the irregular containers. Record your results. Using the standard containers and your box, determine the volume of the irregular containers. Record your results and compare them to your estimates. Estimate each of the following portions first, and then check by actual measurement.

25 ml	500 ml
100 ml	1 000 ml

Liquid Capacity

Materials needed. Sets of plastic metric graduated containers 1 000 ml, 500 ml, 100 ml, 50 ml; Plastic funnels, plastic measuring tablespoons, plastic measuring cups

Directions. Pour various amounts of water into a non-graduated container. Estimate by the number of millilitres, then find the actual amount with a graduated container.

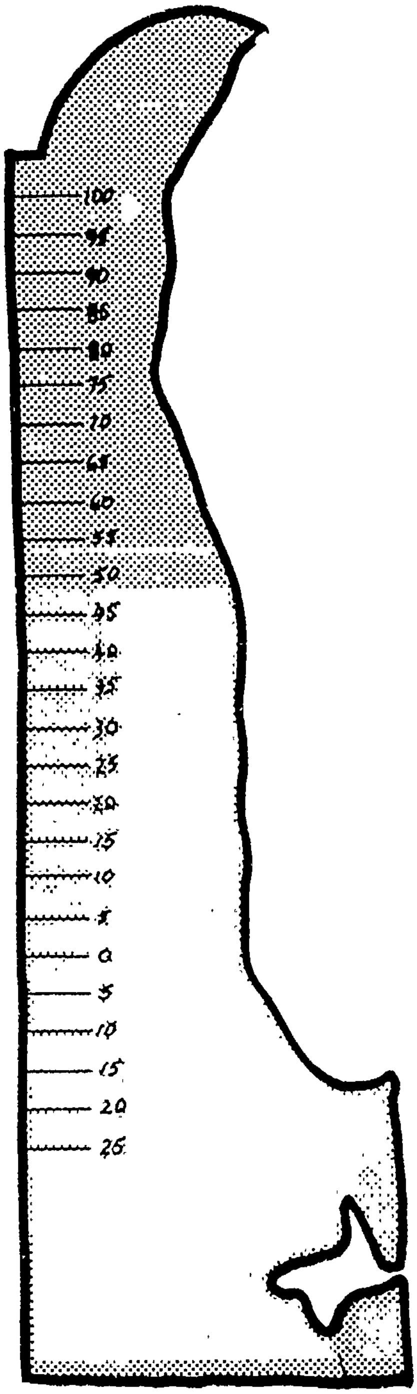
In each of the following activities, first estimate then find the actual capacity. Express the answers as indicated in each activity.

ITEM	ESTIMATE	ACTUAL
Juice container	________ l	________ l
		________ ml
one cup	________ ml	________ ml
		________ l
tablespoon	________ ml	________ ml
teaspoon	ml	________ ml
soda can	________ ml	________ ml
container of your choice	________ ml	________ ml

Which is the better buy? [Check ✓]

3 litres of milk at 90 cents OR

500 millilitres of milk at 20 cents



MEASUREMENT

ACTIVITIES

TEMPERATURE

This section includes the measurement of temperature in the metric system by using the Celsius thermometer scale. The Celsius thermometer was named after Anders Celsius (1701-1744) a Swedish astronomer and scientist from Uppsala, Sweden. He presented the first idea of separating the freezing point and boiling point of water with 100 equal parts. Hence,

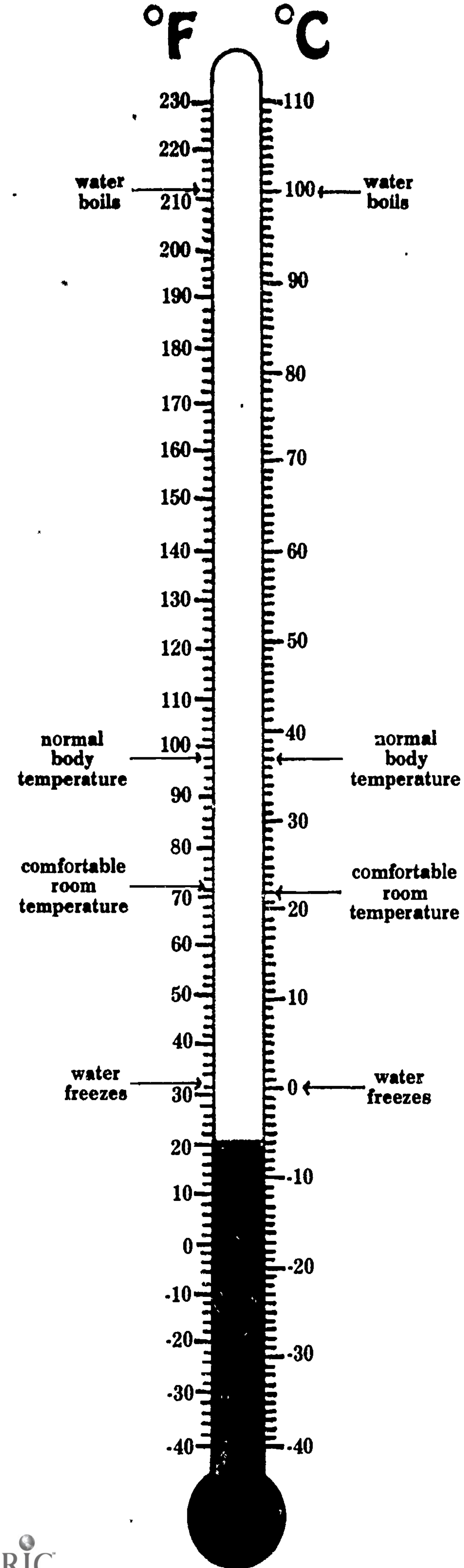
the freezing point of water 0°C
the boiling point of water 100°

100°C - boiling point of water

37° - normal body temperature
30° - beautiful summer day

20° - normal room temperature
10° - beautiful spring day
4° - water at maximum density

0° - freezing point of water



This thermometer shows temperatures in degrees Fahrenheit (°F) and in degrees Celsius (°C). Use the thermometer to answer these questions.

0°C = __________°F

Normal body temperature is__________°C

Comfortable room temperature is__________°F

A nice summer day is 80°F. That is about__________°C.

37°C = __________°F

Water boils at__________°C

100°F is about__________°C

You might wear a sweater at 50°F. That is about__________°C

22°C is comfortable__________________________________.

At 100°C water__________________________________.

Water freezes at__________°C

0°F is about__________°C

-40°F = __________°C

Comfortable room temperature is__________°C

32°F = __________°C

You might go swimming outside when it is 85°F. That is about__________°C

37°C is normal__________________________________.

At 0°C water__________________________________.

22°C is about__________°F

You could go ice skating at 10°F. That is about__________°C

212°F = __________°C

From these clues, mark on this thermometer where you think each of the following temperatures would be placed on the Celsius scale. Place the number of each item below next to its temperature on the thermometer. Compare your estimates with those of some of your classmates.

	Estimate	*Actual*
1. A very hot day in summer	____________	____________
2. A very cold day in winter	____________	____________
3. A bowl of hot soup	____________	____________
4. Ice cream	____________	____________
5. A warm bath	____________	____________
6. A glass of cold soda (without ice)	____________	____________
7. A person with a fever	____________	____________

Temperature: You Be The Judge

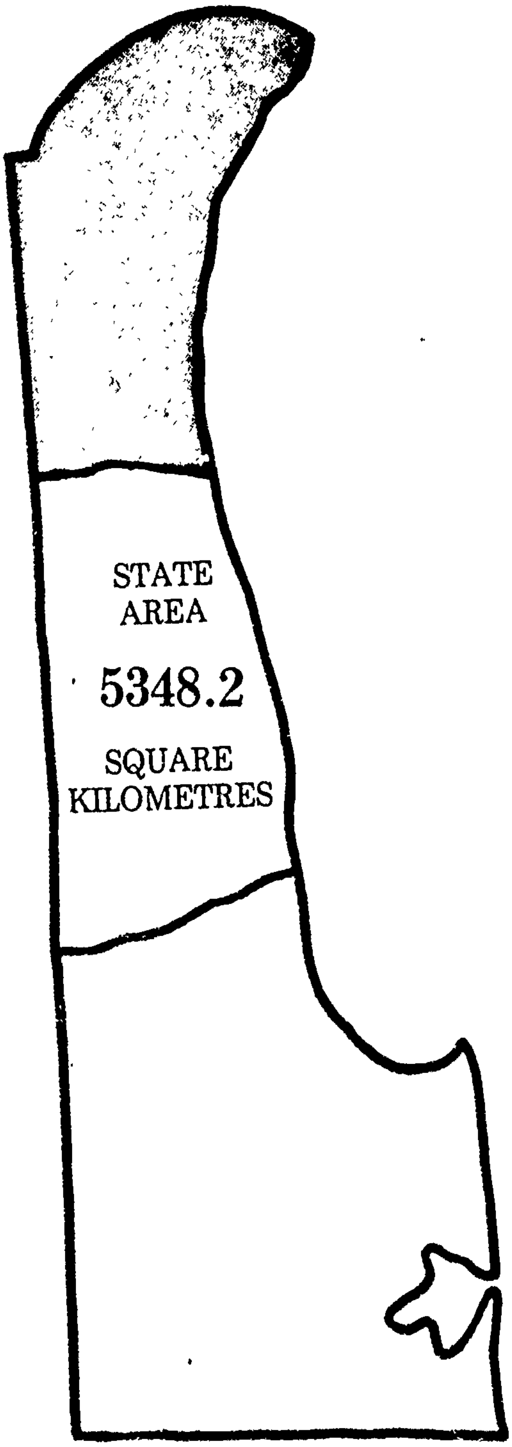
Objective: To make judgements based upon facts about temperature measured in Celsius units.

Activity: For class discussion or written exercise, ask students to answer questions such as the following.

1. The thermometer reads 20°C. Will you need your winter coat? (No!)
2. The thermometer reads 15°C. Will the outdoor swimming pool be open today? (No!)
3. Your doctor takes your temperature, and finds it to be 37°C. Do you have a fever? (No!)
4. If your body temperature is 40°C, are you sick? (Yes!)
5. The temperature is 35°C. Should you go sledding or swimming? (Swimming)
6. It is 15° below zero, Celsius. Will you have trouble keeping warm watching a football game from an outdoor stadium is warmly dressed? (Yes! Don't try it.)
7. The temperature of a cup of cocoa is 50°C. Will it burn your tongue? (No!) What if it's 90°C? (Be very careful)
8. Mom forgot that her new oven is marked in Celsius units. She baked a cake setting her oven thermostat at 375°. What happened? Was the cake all doughy or was it completely dried out and burned? (Dried out and burned)
9. Your bath water is 15°C. Will you have a scalding, warm, or chilly bath? (A chilly bath.)
10. To help save energy, where should you set the room thermostat and still be reasonably comfortable? (20°C)
11. Your Dad exclaims, "Who's been monkeying with the thermostat? It's 27°C in this room! No wonder we're so uncomfortable." Are you shivering or perspiring? (Perspiring)

MEASUREMENT ACTIVITIES

AREA



Common Metric Units
Used in Area and Volume Measurement

Area used the length measurements expressed in:

square millimetre	mm^2
square centimetre	cm^2
square metre	m^2
square kilometre	km^2

Note: 10 000 m^2 is called 1 hectare and is a common land measurement.

Volume uses the length measurements expressed in:

cubic millimetre	mm^3
cubic centimetre	cm^3
cubic metres	m^3
cubic kilometre	km^3

Relationship of Metric Units
for Area and Volume Measurement

Area

100 mm^2	=	1 cm^2
10 000 cm^2	=	1 m^2
1 000 000 m^2	=	1 km^2
10 000 m^2	=	1 hectare

Volume

1 000 mm^3	=	1 cm^3
1 000 000 cm^3	=	1 m^3
1 000 000 000 m^3	=	1 km^3

Area Defined

Area is defined as the amount of surface space. (The area of a rectangle is found by multiplying the length of the surface by the width of the surface.)

Volume is defined as the amount of space occupied by a quantity of matter. (The volume is found by multiplying the length times the width times the height.)

Area Estimation

Materials

30 centimetre rulers showing millimetre divisions
1 metre cloth tape
10 metre tapes (or longer)
5 cardboard boxes of various sizes

Estimate before the actual measurement.

	Estimate	Actual
this rectangle	______ cm^2	______ cm^2

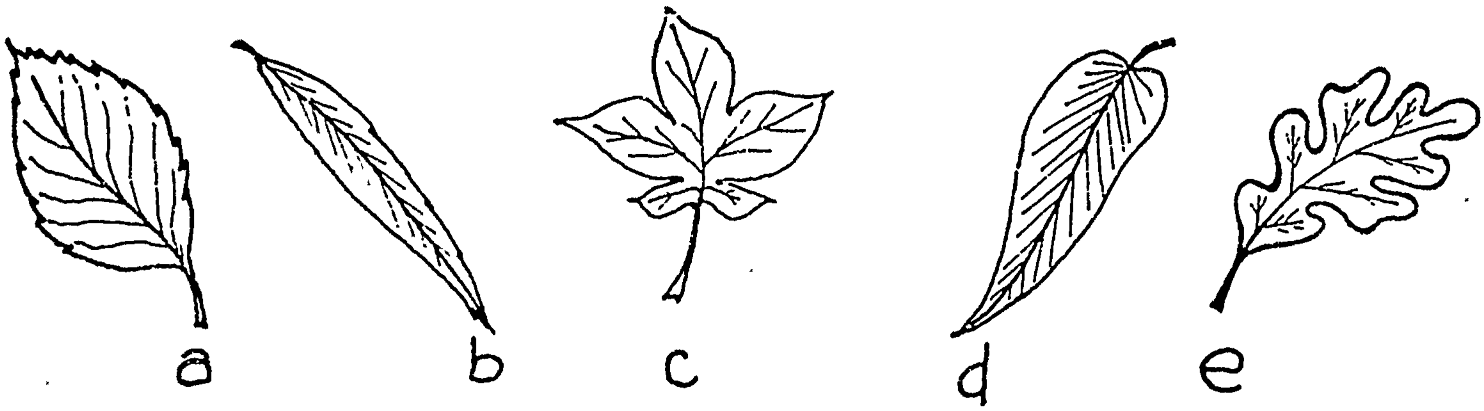
		Estimate	Actual
The bottom	1.	______	______
surfaces of 3	2.	______	______
of the 5 boxes	3.	______	______

	Estimate	Actual
the floor of the room you're in	______ m^2	______ m^2

Hand Area

Materials needed: centimetre ruler and paper.

Materials needed· Make 20 cm x 20 cm graph paper using your centimetre ruler. How many square centimetres on this graph paper? Outline your hand on it and by counting the squares find the area of your hand.



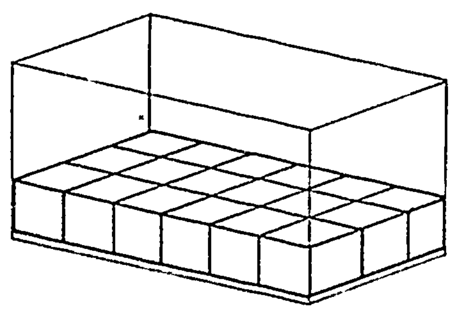
Materials needed: 5 leaves, differing in size or shape

Directions. Label or name the leaves. Estimate how many square centimetres in each leaf. Make a table to record your guesses and measures:

Leaf	Estimate	Measure
a	______ cm^2	______ cm^2
b	______ cm^2	______ cm^2
c	______ cm^2	______ cm^2
d	______ cm^2	______ cm^2
e	______ cm^2	______ cm^2

Now measure the leaves. You may wish to use centimetre grids or paper. Complete the table. Make a display for the class to show the area of each leaf.

Volume Estimation



Materials needed: several boxes of various sizes, cuisenaire rods, ruler

Directions: Estimate how many white rods are needed to fill the smallest box.

Fill the box with white cuisenaire rods and count them. What does this tell you about the volume of the box? Try doing this with another box. Using the ruler, determine the volume of all the boxes. How many cuisenaire rods would fit the volume by measuring with the ruler only?

Find the volume of the following. Estimate before the actual measurement.

	Estimate	Actual	
1.	______	______	3 of the
2.	______	______	5 boxes
3.	______	______	

Estimate	Actual	
		the room
______ m^3	______ m^3	you're in to
		height of 3 m

Measurement Pretest

In each of the following questions, choose the answer you think is correct and place a check mark in the space provided.

1. A gram is about the weight of:

   ________ an apple
   ________ a dime
   ________ a pineapple
   ________ not sure

2. A metre is about the height of:

   ________ a door
   ________ a table
   ________ a chair seat
   ________ not sure

3. Water freezes and boils at:

   ________ 32°C and 212°C
   ________ 100° and 200°
   ________ 0°C and 100°C
   ________ not sure

4. A measuring cup would hold about.

   ________ 2 millilitres
   ________ 20 millilitres
   ________ 200 millilitres
   ________ not sure

5. A new born baby weighs about:

   ________ 3 kilograms
   ________ 30 kilograms
   ________ 300 kilograms
   ________ not sure

6. A tall man is about:

   ________ 20 centimetres high
   ________ 200 centimetres high
   ________ 2000 centimetres high
   ________ not sure

7. Normal body temperature is about:

   ________ 25°C
   ________ 37°C
   ________ 45°C
   ________ not sure

8. A 12 oz. soft drink bottle holds about:

   ________ 1.5 litres
   ________ 1 litre
   ________ 0.3 litres
   ________ not sure

9. A litre of waters weighs about:

   ________ 100 grams
   ________ 10 grams
   ________ 1000 grams
   ________ not sure

10. A new lead pencil is about:

    ________ 50 millimetres long
    ________ 100 millimetres long
    ________ 200 millimetres long
    ________ not sure

11. One teaspoonful of cough syrup would be about:

    ________ 0.5 millilitres
    ________ 1 millilitre
    ________ 5 millilitres
    ________ not sure

12. A professional football player weighs about:

    ________ 45 kilograms
    ________ 100 kilograms
    ________ 180 kilograms
    ________ not sure

13. A dollar bill is about:

    ________ 15 centimetres x 7 centimetres
    ________ 20 centimetres x 10 centimetres
    ________ 100 centimetres x 70 centimetres
    ________ not sure

14. The thickness of a dime would be about:

    ________ 0.1 millimetres
    ________ 1 millilitre
    ________ 5 millilitres
    ________ not sure

Measurement Posttest

In each of the following questions, choose the answer you think is correct and place a check mark in the space provided.

1. A gram is about the weight of:

(a)_______ an apple
(b)_______ a dime
(c)_______ a pineapple
(d)_______ not sure

2. A metre is about the height of:

(a)_______ a door
(b)_______ a table
(c)_______ a chair seat
(d)_______ not sure

3. Water freezes and boils at:

(a)_______ 32°C and 212°C
(b)_______ 100°C and 200°C
(c)_______ 0°C and 100°C
(d)_______ not sure

4. A measuring cup would hold about:

(a)_______ 2 millilitres
(b)_______ 20 millilitres
(c)_______ 200 millilitres
(d)_______ not sure

5. A new born baby weighs about:

(a)_______ 3 kilograms
(b)_______ 30 kilograms
(c)_______ 300 kilograms
(d)_______ not sure

6. A tall man is about:

(a)_______ 20 centimetres high
(b)_______ 200 centimetres high
(c)_______ 2000 centimetres high
(d)_______ not sure

7. Normal body temperature is about:

(a)_______ 25°C
(b)_______ 37°C
(c)_______ 45°C
(d)_______ not sure

8. A 12 oz. soft drink bottle holds about:

(a)_______ 1.5 litres
(b)_______ 1 litre
(c)_______ 0.3 litres
(d)_______ not sure

9. A litre of waters weighs about:

(a)_______ 100 grams
(b)_______ 10 grams
(c)_______ 1000 grams
(d)_______ not sure

10. A new lead pencil is about:

(a)_______ 50 millimetres long
(b)_______ 100 millimetres long
(c)_______ 200 millimetres long
(d)_______ not sure

11. One teaspoonful of cough syrup would be about:

(a)_______ 0.5 millilitres
(b)_______ 1 millilitre
(c)_______ 5 millilitres
(d)_______ not sure

12. A professional football player weighs about:

(a)_______ 45 kilograms
(b)_______ 100 kilograms
(c)_______ 180 kilograms
(d)_______ not sure

13. A dollar bill is about:

(a)_______ 15 centimetres x 7 centimetres
(b)_______ 20 centimetres x 10 centimetres
(c)_______ 100 centimetres x 70 centimetres
(d)_______ not sure

14. The thickness of a dime would be about:

(a)_______ 0.1 millimetres
(b)_______ 1 millilitre
(c)_______ 5 millilitres
(d)_______ not sure

15. The standard of length in the metric system is the:

(a)_______ millimetre
(b)_______ centimetre
(c)_______ decimetre
(d)_______ kilometre
(e)_______ metre

16. The liquid capacity of a jar is 0.75 litres. This is equivalent to:

(a)_______ 75 millilitres
(b)_______ 75 cubic centimetres
(c)_______ 7.5 cubic centimetres
(d)_______ 750 millilitres
(e)_______ 7500 millilitres

17. A desk top is 65 centimetres across. This is equivalent to:

(a)_______ 650 millimetres
(b)_______ 0.65 metres
(c)_______ 6.5 metres
(d)_______ 0.065 kilometres
(e)_______ 6500 millimetres

18. The appropriate numerical factors for milli, centi, and kilo are:

(a)_______ x 1000; x 100; x10
(b)_______ x 0.001; x 0.01; x 1000
(c)_______ x 10; x 1000; x 1000
(d)_______ x 100; x 10; x 0.1
(e)_______ don't know

19. The base temperature scale used in the metric system (SI) from which the derived units orginate is the:

(a)_______ Celsius scale
(b)_______ Kelvin scale
(c)_______ Fahrenheit scale
(d)_______ Centigrade scale

20. A certain container holds 1500 cubic centimetres of a substance. How many millilitres and litres respectively would it hold?

(a)_______ 150 millilitres and 15 litres
(b)_______ 1500 millilitrer and 1.5 litres
(c)_______ 15 millilitres and 150 litres
(d)_______ cubic centimetres and litres
(e)_______ don't know

Guidelines For Conducting A Metric Workshop

This section has been included as a guide for those teachers planning to conduct a workshop approach in teaching the metric system. It basically attempts to answer the question, "What is required to plan and develop a meaningful metric workshop?"

The writing team believes that the approach used in this program can also be used, with modifications, for students. The guidelines will be outlined under the headings:

A. Pre-planning
B. Organization
C. Procedure
D. Follow-up

Pre-Planning

Pre-planning includes both the preparation of the instructor as well as the preparation of the participants prior to the workshop. Before the actual workshop the instructor should become familiar with:

A brief history of the metric system. Why it began, where it began, where it is being used, its development to the present International System of Units (SI), and its historical development.
Why go metric? A justification for going metric, advantages.
The metric system. The units of measurement, decimal nature, prefixes, and their meaning, the relationship within each unit of measurement, the interrelationship of the various measurement units, simplicity of the system.
The THINK METRIC concept. New language of measurement, no conversion between the customary system and the metric system.

From this background knowledge the instructor should be able to prepare the participants for the actual workshop.

Organization

The organization includes the involvement of the instructor prior to the actual workshop. The following should be considered.

What is the purpose of the workshop. Which unit(s) of measurement is going to be dealt with in the workshop?
Time and available room should be decided - atmosphere suitable for this kind of activity, tables are preferable to desks, ease of movement for participants, limit the number of participants per workshop to perhaps thirty or fewer and also limit the number of participants per table to ten or fewer.
Sufficient materials. Preferable to have participants work in groups of two, supply enough materials so that each group of two can work easily, materials will depend on the activities.
Workshop activities. Select the workshop activities that would interest your participants, require them to estimate first -- it causes them to think metric, instructor should do activities before the participants do them to make necessary modifications, etc.

Procedure

This involves the workshop activities themselves and assumes that the pre-planning and the organization have been completed. The following should be considered:

Statement of purpose. Actual measurement in the metric system, estimate first, think metric, no conversion from customary system.
Explanation of procedure. Work in groups of two, amount of time, perhaps use a questionnaire as an "interest getter", etc.
Time element. Approximately 30 minutes have been found satisfactory for many of the activities outlined in this program under Length Measurement, Capacity Measurement, and Mass Measurement.

Follow-up

The following suggestions could be considered in a discussion of the workshop:

The metric units of measurement used.
The advantages of the metric system.
The decimal nature of the metric system.
The relationship within the unit of measurement used.
The use of the prefixes and their meaning.
The interrelationship if more than one unit of measurement was used.
The simplicity of the metric system.
The accuracy of the estimations.
How can you think metric?

Volume and Capacity

Estimate and measure various sizes of bottles and containers.
Look for measures on consumer products.
Construct cm^3 blocks to find various volumes.

Additional Activities

An Olympic Day - pupils involved in planning the varied events and setting up the courses.
Treasure Hunts - pupils plan hunts making maps based on metric measures. Groups of children make use of maps to find treasures.
Puppet Theatre - pupils plan and build theatre for the classroom based on metric measures.
Measuring the Impossible
Have the pupils list things they think are impossible to measure - height of school, height of classroom, etc.
Allow pupils to devise a means of measuring the varied lengths or heights to determine those that are really impossible.
Plan a trip using the metric system with the Delaware map. Compute the amount of gas you will use.

Integration with the Curriculum

Language

Work investigatin. Using words obtained from measurement activities (length, metre). Discuss vowel sounds, silent consonants, etc.
News flashes. Historical development of metric system, how, who, what, where, why.
Drama. Historical development of metric units.
Mother May I? To reinforce understanding of various linear dimensions. Take 5 metre steps.

Music

Song writing. Pupils take familiar tunes and make up their own words with the metric system in mind.

Art

Metric monsters. Using pipe cleaners, create figures conforming to metric specifications.
String pictures. Measure string in various metric lengths. Create a design of the string on the colored paper.
Mural. To illustrate the activities and findings of the metric system as they find them.

Social Studies

Survey. Visit the local supermarket to locate products packaged in metric units. Collect and display.

SUPPLEMENTARY ACTIVITIES

Metric Recipes

Kokosberge

125 g margarine	125 g flour
100 g sugar	80 g cornstarch
1 tsp. vanilla	9 g baking powder
1 egg	100 g coconut

Cream margarine. Add sugar, vanilla, and egg. Sift cornstarch, baking powder, and flour together. Mix slowly into creamed mixture. Add coconut.

Drop by teaspoonful on lightly greased baking sheet.

Bake at 350°F (175°C) for 10 minutes.

Oatmeal Cookies

85 g margarine	3 drops vanilla
140 g oats	1 egg
85 g sugar	58 g flour

Melt butter, add oats, and 10 g sugar. Remove from heat. Beat egg till frothy. Add 75 g sugar and vanilla. Slowly add oat mixture and flour to egg mixture. Drop by teaspoonful on greased baking sheet. Bake 15 to 20 minutes at 300°F (150°C).

Vanilla Ice Cream

10 g cornstarch	2 egg yolks
75 g sugar	10 ml milk
2 tsp vanilla	420 ml milk

Blend cornstarch, sugar, vanilla, egg yolks, and 10 ml milk. Brin 420 ml milk to boil. Remove from heat and stir in cornstarch mixture. Bring to boil again and cook for a few seconds. Leave to cool stirring frequently. Pour into container and freeze.

Metric Cake

Grease and line with paper a 24 x 12 x 8 centimetre loaf pan.

Sift together into bowl: 500 g flour, 225 g sugar, 10 g baking powder, and 5 g salt. Add: 125 g soft shortening, 5 millilitre vanilla, 5 egg yolks, and 110 millilitre milk.

Beat two minutes, then add 55 millilitres milk. Stir. Spoon batter into prepared pan. Bake 60 - 70 minutes in a moderate oven, 185° Celsius. Cool. Ice with orange glaze.

RESOURCE MATERIALS

AIDS

Decimal Multiples.
A cube game to reinforce place value of metric prefixes.

Meter-Liter-Gram. Hampton, Wesley J. 1973.
An educational board game designed for learning the metric system.

Metrication Masters. Hoffman, Sylvia A. 1973.
Pad of 50 masters Very easy to read, uncluttered pages. All units of the metric system are covered. Includes activities and mini-problems.

Metric Masters - Duplicating Master. Maxey, Franklin.
For grades 5 - 8.

Metric Aritmapuzzles.
Set of cross number puzzles to reinforce metric concepts.

Metrication.
Game which reinforces place value base 10 relationships in the metric system by its prefixes. Similar to Monopoly.

Metric Songs.
Great Ideas, Inc., P.O. Box 274, Commack, N. Y. 11725 $9.50 Tape cartridge of simple metric songs for K-3.

Metric System Skills.
Skill and drill through recordings. Self correcting.
1. Introducing the metric system.
2. Working with basic prefixes.
3. Metric units of length, weight, and capacity.

Metric-Tac-Toe.
A tic-tac-toe game with 3 cubes marked with metric terms which reinforces movement of decimal point to convert within metric system.

Practice in the Metric System.
Duplicating masters for secondary level. Problems of conversion between customary and metric system are included.

BOOKS/PAMPHLETS

Metric-Aid Series (1 through 4).
Antoine, Valerie. Metric Association, 10245 Andasol Avenue, Northridge, CA 91234. 1974.
These lessons were created by Valerie Antoine who is the Litton Data Systems Metric Planning Director. The background of the basic metric units is presented as well as relating them to everyday objects. Well illustrated.

Think Metric
Branley, Franklyn M. Thomas Y. Crowell and Company, New York, New York. 1972.
Geared to the upper grades and secondary level. Measurement exercises are provided.

Introducing the Metric System with Activities. Buckeye, Donald A. Midwest Publications, Inc., P.O. Box 307, Birmingham, Michigan 48012. Ungraded. Suggestions for activities for the basic metric units.

I'm O.K. - You're O.K. - Let's Go Metric. Buckeye, Donald A. Midwest Publications, Inc., P.O. Box 307, Birmingham, Michigan 48012. 1973.
Puzzles and activities to motivate and reinforce metric concepts for intermediate grades.

Amusements in Developing Metric Skills. Clack, A.A. and Leitch, C.H. Midwest Publications, Inc., P.O. Box 307, Birmingham, Michigan 48012. 1973.
Puzzles and activities to motivate the learning of the metric system in the upper grades and secondary level.

Discover... Why Metrics. Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.
Develops in similar fashion to film and posters of same company. Geared for secondary level and industry.

Thinking Metric. Gilbert. John Wiley and Sons, 605 Third Avenue, New York, New York 10016. 1973.
Self-teaching guide.

Neater by the Meter. Glaser, Anton, 1237 Whitney Road, Southampton, Pennsylvania 18966. 1974.
A very complete well illustrated paperback that is an excellent resource book for metrication. The emphasis is on "thinking metric", not conversion.

Let's Play Games in Metrics. Henderson, G. L. and Glunn L. D. National Textbook Company. Skokie, Illinois 60076. 1974.
Informational background for the metric system folowed by 177 games and activities geared for lower, middle, and upper grades.

Teaching the Metric System. Henry, Boyd. Weber Costello, Department AT 3, 1900 N. Narragansett Avenue, Chicago, Illinois 60639.
Stresses manipulative activities for understanding the common metric units.

Metric News. Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 60639.
Metric magazine published bimonthly.

Metric Units of Measurement. Metric Association, 10245 Andasol Avenue, Northridge, California 91324.
Background information for the teacher.

The Internatiional (SI) Metric System and How It Works. Siggson, A.N. Polymetric Services, Inc., P.O. Box Drawer L, Tarzana, California 91356.
Aimed toward industrial problems of metrication.

Metric Measurement - Activities and Bulletin Boards. Trueblood, Cecil R. Instructor Curriculum Materials, Dansville, Kentucky 14437.
Many teaching aids.

U.S.A. Goes Metric.
Basic introduction to the metric system developed by Regal-Boloit for their employees.

FILMS

A Metric America. Aimes Instructional Media Services, P.O. Box 1010, Hollywood, California.
An excellent 16 minute film which demonstrates the need for the adoption by the United States of the metric system from an amusing story of the Wimples and their confusing measuring system.

Discover - Why Metrics. Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.
An amusing cartoon with "Metric Mike" as the central character discovering the basic metric units and their uses.

International System of Units. King Screen Productions, 320 Aurora Avenue, North Seattle, Washington 98109.
Technical background of metric units. For senior high or college level. 22 minutes.

Let's Go Metric. John Wiley and Sons, 605 Third Avenue, New York, New York 10016.
A 20 minute film for secondary or industrial level. Converts between customary and metric systems. Teacher's guide is $.50.

Metric Measurements. Oxford Films, Inc., 1136 N. Las Palmas Avenue, Hollywood, California 90038.
Three films (Weight and Mass, Length and Distance, Volume and Capacity)

The Metric System. McGraw-Hill Films, Text-Film Division, 1221 Avenue of the Americas, New York, New York 10026.
Origin and basic units of metric system are presented. Prefixes are defined. For secondary level. Thirteen minutes.

The Metric System. N.B.C. Educational Enterprises, Inc., Film Exchange, Route Animated cartoon relating metric system to common objects.

FILMSTRIPS

Advantages of Going Metric. Creative Visuals, Box 1911, Big Springs, Texas 79720.
First of series planned for intermediate and junior high.

English or Metric, That is the Question, Segment 1. Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.
A set of 4 filmstrips with cassettes giving the background for the metric units appropriate for the junior high math and/or science class. A teacher's manual and script is included.

English or Metric, That is the Question, Segment 2, Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.
A set of 4 filmstrips with cassettes for the senior high math and/or science class using the metric units as functions of time, force, etc. Teacher's manual and script is ncluded.

Introducing the Metric System. BFA Educational Media, 2211 Michigan Avenue, Santa Monica, California 90404.
Four sound filmstrips with records or cassettes, illustrating the relationships between the basic metric units. A teacher's manual set of task cards, and centimeter rulers are included.

Introduction to the International System of Units. S.V.E., Society for Visual Education, Inc., Division of Singer Company, 1345 Diversey Parkway, Chicago, Illinois 60614.
Geared to the senior high and adult level.

The Metric System. Eye-Gate House, Inc., 146-01 Archer Avenue, Jamaica, New York 11435.
Gives historical background of measuring units. Explains metric terminology.

The Metric System - The Universal Language of Measurement. Pathescope Educational Films, Inc., New Rochelle, New York 10802.
Six filmstrips with records or cassette. Covers topics in depth. Geared for secondary level.

Think Metric. Educational Products, Inc., 5005 W. 110th Street, Oak Lawn, Illinois 60453.
Two sound filmstrips with cassetts which introduce the basic metric units. The script, suggested pre and post activities. A "Go Metric" bumper sticker and "The Metric Units of Measure" published by the Metric Association, Inc. are included.

Think Metric. Miller-Brody Productions, 342 Madison Avenue, New York 10017.
Four filmstrips to present metric units, prefixes, internal relationships and internal conversion.

Think Metric. Understanding and Using the Metric System. Audio-Visuals, 1754 West Farrgue Avenue, Chicago, Illinois 60640.
Set of 80 slides in carousel cartridge.

BIBLIOGRAPHY LISTS

The Metric System - Quick List. Baker and Taylor Company, Audio-Visual Services Division, P.O. Box 230, Momence, Illinois 60954.
A list of fims and filmstrips on the metric system with the price and producer of each.

One To Get Ready. AASL/nctm, 50 East Huron Street, Chicago, Illinois 60611.
Background information plus bibliography list.

All You Will Need to Know About Metric. Metric Information Office, National Bureau of Standards, Washington, D.C. 20234.
One large wall chart and/or classroom quantities (8½ x 11). Contains information needed for common metric units.

Brief History of Measurement Systems. National Bureau of Standards, Superintendent of Documents, Washington, D.C. 20402.

Classroom Metric Lines. Instructor Curriculum Materials, Dansville, Kentucky 14437.
Set of 8 separate line-charts with "Wrtie and Wipe" surface.

Learning How to Use the Metric System. Miller - Brody Productions, 342 Madison Avenue, New York, New York 10017.
Small wall chart comparing customary and metric measures.

Metric Place Value Chart. Ideal School Supply Company, 11000 S. Lavergne Avenue, Oak Lawn. Illinois 60453.

Metric Posters. Creative Publications, Inc., P.O. Box 10328, Palo Alto, California 94303.
Four colorful posters (4.56 cm x 86 cm): History of Measurement, It's A Metric World, World Records (measured in metric units), Think Metric (demonstrates simplicity of metric units)

Metric Training Wall Posters. Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.
Set of ten posters showing "Metric Mike". Very colorful.

Metric Wall Chart. National Bureau of Standards, Superintendent of Documents, Washington, D.C. 20402.
Special publication #304. Full scale chart is 73 cm x 114 cm.

Metric Wall Chart. Ideal School Supply Company, 11000 S. Lavergne Avenue, Oak Lawn, Illinois 60453.
Illustrates basic metric units.

Modernized Metric System.
This chart is available from the U.S. Army Recruiting Service. It defines and illustrates the basic SI units.

The Metric System. Instructor Curriculum Materials, Dansville, Kentucky 14437.
Twelve wall charts illustrating the basic metric units. Now being revised to eliminate conversion between customary metric measures.

The Metric System. Milton Bradley Company (available through distributors)
A set of colorful wall charts to develop metric concepts.

SOURCES OF INFORMATION

National Bureau of Standards, Jeffrey V. Odom, Metric Information Office, U.S. Department of Commerce, Washington, D.C. 20234.

American National Metric Council, Dr. Malcolm O'Hagan, Executive Director, 1625 Massachusetts Avenue, N.W., Fifth Floor, Washington, d.c. 20036.

O S Metric Association, Inc., Louis F. Sokol, President, Sugarloaf Star Route, Boulder, Colorado 80302.

Center for Metric Education, D. John L. Feirer, Director, Western Michigan University, Kalamazoo, Michigan 49001.

American Institutes for Research, Metric Studies Center, P.O. Box 1113, Palo Alto, California 94302.

REFERENCE BOOKS AND JOURNALS

The International System of Units (SI), National Bureau of Standerds, (U.S.) Special Publication 330, 42 pages, 1972, 30 cents. (SI) Catalog Number (13.10:33012).

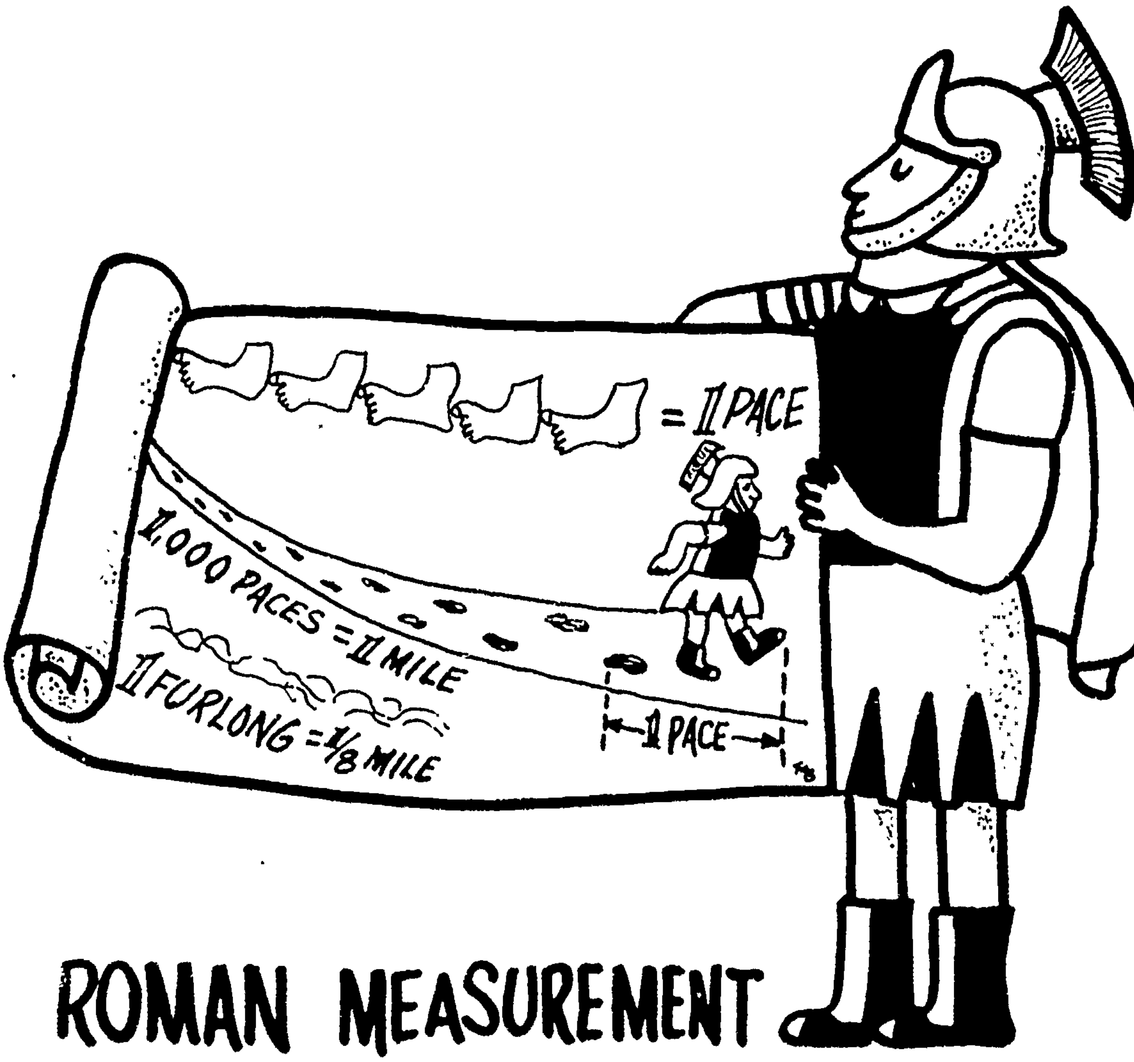
Metric SI/USA, 1906 Main Street, Cedar Falls, Iowa. 50613.

Metric Practice Guide, E-380-72, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

Metric News, ($5.00 year). Metric magazine published bi-monthly, Swani Publishing Company, P.O. Box 248, Roscoe, Illinois 61073.

Metric System Guide Series, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, Neenah, Wisconsin 54956.

The American Metric Journal, ($35.00 Year), AMJ Publishing Company, P.O. Drawer L, Tarzana, California 91356.



DEGREE OF THE METRE

This Degree is to certify that

has successfully completed the awareness program

Introduction to Metric Measurement

and is entitled to use the metric system

in any manner necessary.

Given this____________________day of____________________19________.

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