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THE CENTER FOR VOCATIONAL EDUCATION

TEACHING AND LEARNING THE METRIC SYSTEM

This metric instructional package was designed to meet job-related metric measurement needs of students. To use this package students should already know the occupational terminology, measurement terms, and tools currently in use. These materials were prepared with the help of experienced vocational teachers, reviewed by experts, tested in classrooms in different parts of the United States, and revised before distribution.

Each of the five units of instruction contains performance objectives, learning activities, and supporting information in the form of text, exercises, and tables. In addition, suggested teaching techniques are included. At the back of this package are objective-based evaluation items, a page of answers to the exercises and tests, a list of metric materials needed for the activities, references, and a list of suppliers.

Classroom experiences with this instructional package suggest the following teaching-learning strategies:

1. Let the first experiences be informal to make learning the metric system fun.
2. Students learn better when metric units are compared to familiar objects. Everyone should learn to "think metric." Comparing metric units to customary units can be confusing.
3. Students will learn quickly to estimate and measure in metric units by "doing."
4. Students should have experience with measuring activities before getting too much information.
5. Move through the units in an order which emphasizes the simplicity of the metric system (e.g., length to area to volume).
6. Teach one concept at a time to avoid overwhelming students with too much material.

Unit 1 is a general introduction to the metric system of measurement which provides informal, hands-on experiences for the students. This unit enables students to become familiar with the basic metric units, their symbols, and measurement instruments; and to develop a set of mental references for metric values. The metric system of notation also is explained.

Unit 2 provides the metric terms which are used in this occupation and gives experience with occupational measurement tasks.

Unit 3 focuses on job-related metric equivalents and their relationships.

Unit 4 provides experience in recognizing and using metric units, terms, and symbols in proofing, typing, layout, and shorthand tasks.

Unit 5 is designed to give students practice in converting customary and metric measurements. Students should learn to "think metric" and avoid comparing customary and metric units. However, skill with conversion tables will be useful during the transition to metric in each occupation.

Using These Instructional Materials

This package was designed to help students learn a core of knowledge about the metric system which they will use on the job. The exercises facilitate experiences with measurement instruments, tools, and devices used in this occupation and job-related tasks of estimating and measuring.

This instructional package also was designed to accommodate a variety of individual teaching and learning styles. Teachers are encouraged to adapt these materials to their own classes. For example, the information sheets may be given to students for self-study. References may be used as supplemental resources. Exercises may be used in independent study, small groups, or whole-class activities. All of the materials can be expanded by the teacher.

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Joel H. Magisos
Editors

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UNIT 1

SUGGESTED TEACHING SEQUENCE

1. These introductory exercises may require two or three teaching periods for all five areas of measurement.
2. Exercises should be followed in the order given to best show the relationship between length, area, and volume.
3. Assemble the metric measuring devices (rules, tapes, scales, thermometers, and measuring containers) and objects to be measured.*
4. Set up the equipment at work stations for use by the whole class or as individualized resource activities.
5. Have the students estimate, measure, and record using Exercises 1 through 5.
6. Present information on notation and make Table 1 available.
7. Follow up with group discussion of activities.

*Other school departments may have devices which can be used. Metric suppliers are listed in the reference section.

THE CENTER FOR VOCATIONAL EDUCATION

OBJECTIVES

The student will demonstrate these skills for the Linear, Area, Volume or Capacity, Mass, and Temperature Exercises, using the metric terms and measurement devices listed here.

SKILLS	EXERCISES				
	Linear (pp. 3 - 4)	Area (pp. 5 - 6)	Volume or Capacity (pp. 7 - 8)	Mass (pp. 9 - 10)	Temperature (p. 11)
1. Recognize and use the unit and its symbol for: 2. Select, use, and read the appropriate measuring instruments for: 3. State or show a physical reference for:	millimetre (mm) centimetre (cm) metre (m)	square centimetre (cm^2) square metre (m^2)	cubic centimetre (cm^3) cubic metre (m^3) litre (l) millilitre (ml)	gram (g) kilogram (kg)	degree Celsius (°C)
4. Estimate within 25% of the actual measure	height, width, or length of objects	the area of a given surface	capacity of containers	the mass of objects in grams and kilograms	the temperature of the air or a liquid
5. Read correctly	metre stick, metric tape measure, and metric rulers		measurements on graduated volume measuring devices	a kilogram scale and a gram scale	A Celsius thermometer

RULES OF NOTATION

1. Symbols are not capitalized unless the unit is a proper name (mm *not* MM).
2. Symbols are not followed by periods (m *not* m.).
3. Symbols are not followed by an *s* for plurals (25 g *not* 25 gs).
4. A space separates the numerals from the unit symbols (4 l *not* 4l).
5. Spaces, not commas, are used to separate large numbers into groups of three digits (45 271 km *not* 45,271 km).
6. A zero precedes the decimal point if the number is less than one (0.52 g *not* .52 g).
7. Litre and metre can be spelled either with an -re or -er ending.

METRIC UNITS, SYMBOLS, AND REFERENTS

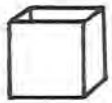
Quantity	Metric Unit	Symbol	Useful Referents
Length	millimetre	mm	Thickness of dime or paper clip wire
	centimetre	cm	Width of paper clip
	metre	m	Height of door about 2 m
	kilometre	km	12-minute walking distance
Area	square centimetre	cm^2	Area of this space 
	square metre	m^2	Area of card table top
	hectare	ha	Football field including sidelines and end zones
Volume and Capacity	millilitre	ml	Teaspoon is 5 ml
	litre	l	A little more than 1 quart
	cubic centimetre	cm^3	Volume of this container 
	cubic metre	m^3	A little more than a cubic yard
Mass	milligram	mg	Apple seed about 10 mg, grain of salt, 1 mg
	gram	g	Nickel about 5 g
	kilogram	kg	Webster's Collegiate Dictionary
	metric ton (1 000 kilograms)	t	Volkswagen Beetle

Table 1–a

METRIC PREFIXES

Multiples and Submultiples	Prefixes	Symbols
$1\ 000\ 000 = 10^6$	mega (mĕg′à)	M
$1\ 000 = 10^3$	kilo (kĭl′ō)	k
$100 = 10^2$	hecto (hĕk′tō)	h
$10 = 10^1$	deka (dĕk′a)	da
Base Unit $1 = 10^0$		
$0.1 = 10^{-1}$	deci (dĕs′ĭ)	d
$0.01 = 10^{-2}$	centi (sĕn′tĭ)	c
$0.001 = 10^{-3}$	milli (mĭl′ĭ)	m
$0.000\ 001 = 10^{-6}$	micro (mī′krō)	μ

Table 1–b

LINEAR MEASUREMENT ACTIVITIES

Metre, Centimetre, Millimetre

I. THE METRE (m)

A. DEVELOP A FEELING FOR THE SIZE OF A METRE

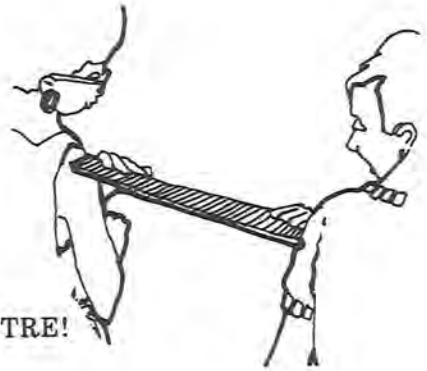
1. Pick up one of the metre sticks and stand it up on the floor. Hold it in place with one hand. Walk around the stick. Now stand next to the stick. With your other hand, touch yourself where the top of the metre stick comes on you

THAT IS HOW HIGH A METRE IS!

2. Hold one arm out straight at shoulder height. Put the metre stick along this arm until the end hits the end of your fingers. Where is the other end of the metre stick? Touch yourself at that end.

THAT IS HOW LONG A METRE IS!

3. Choose a partner to stand at your side. Move apart so that you can put one end of a metre stick on your partner's shoulder and the other end on your shoulder. Look at the space between you.



THAT IS THE WIDTH OF A METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN METRES

Now you will improve your ability to estimate in metres. Remember where the length and height of a metre was on your body.

For each of the following items:

Estimate the size of the items and write your estimate in the ESTIMATE column. Measure the size with your metre stick and write the answer in the MEASUREMENT column.

Decide how close your estimate was to the actual measure. If your estimate was within 25% of the actual measure you are a "Metric Marvel."

		Estimate (m)	Measurement (m)	How Close Were You?
1.	Height of door knob from floor.	_____	_____	_____
2.	Height of door.	_____	_____	_____
3.	Length of table.	_____	_____	_____
4.	Width of table.	_____	_____	_____
5.	Length of wall of this room.	_____	_____	_____
6.	Distance from you to wall.	_____	_____	_____

Exercise 1

(continued on next page)

II. THE CENTIMETRE (cm)

There are 100 centimetres in one metre. If there are 4 metres and 3 centimetres, you write 403 cm [(4 x 100 cm) + 3 cm = 400 cm + 3 cm].

A. DEVELOP A FEELING FOR THE SIZE OF A CENTIMETRE

1. Hold the metric ruler against the width of your thumbnail. How wide is it? _____ cm
2. Measure your thumb from the first joint to the end. _____ cm
3. Use the metric ruler to find the width of your palm. _____ cm
4. Measure your index or pointing finger. How long is it? _____ cm
5. Measure your wrist with a tape measure. What is the distance around it? _____ cm
6. Use the tape measure to find your waist size. _____ cm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CENTIMETRES

You are now ready to estimate in centimetres. For each of the following items, follow the procedures used for estimating in metres.

		Estimate (cm)	Measurement (cm)	How Close Were You?
1.	Length of a paper clip.	_____	_____	_____
2.	Diameter (width) of a coin.	_____	_____	_____
3.	Width of a postage stamp.	_____	_____	_____
4.	Length of a pencil.	_____	_____	_____
5.	Width of a sheet of paper.	_____	_____	_____

III. THE MILLIMETRE (mm)

There are 10 millimetres in one centimetre. When a measurement is 2 centimetres and 5 millimetres, you write 25 mm [(2 x 10 mm) + 5 mm = 20 mm + 5 mm]. There are 1 000 mm in 1 m.

A. DEVELOP A FEELING FOR THE SIZE OF A MILLIMETRE

Using a ruler marked in millimetres, measure:

1. Thickness of a paper clip wire. _____ mm
2. Thickness of your fingernail. _____ mm
3. Width of your fingernail. _____ mm
4. Diameter (width)of a coin. _____ mm
5. Diameter (thickness) of your pencil. _____ mm
6. Width of a postage stamp. _____ mm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLIMETRES

You are now ready to estimate in millimetres. For each of the following items, follow the procedures used for estimating in metres.

		Estimate (mm)	Measurement (mm)	How Close Were You?
1.	Thickness of a nickel.	_____	_____	_____
2.	Diameter (thickness) of a bolt.	_____	_____	_____
3.	Length of a bolt.	_____	_____	_____
4.	Width of a sheet of paper.	_____	_____	_____
5.	Thickness of a board or desk top.	_____	_____	_____
6.	Thickness of a button.	_____	_____	_____

AREA MEASUREMENT ACTIVITIES

Square Centimetre, Square Metre

WHEN YOU DESCRIBE THE AREA OF SOMETHING, YOU ARE SAYING HOW MANY SQUARES OF A GIVEN SIZE IT TAKES TO COVER THE SURFACE.

I. THE SQUARE CENTIMETRE (cm^2)

A. DEVELOP A FEELING FOR A SQUARE CENTIMETRE

1. Take a clear plastic grid, or use the grid on page 6.
2. Measure the length and width of one of these small squares with a centimetre ruler.

   THAT IS ONE SQUARE CENTIMETRE!

3. Place your fingernail over the grid. About how many squares does it take to cover your fingernail?
   _____cm^2
4. Place a coin over the grid. About how many squares does it take to cover the coin? _____cm^2
5. Place a postage stamp over the grid. About how many squares does it take to cover the postage stamp?
   _____cm^2
6. Place an envelope over the grid. About how many squares does it take to cover the envelope?
   _____cm^2
7. Measure the length and width of the envelope in centimetres. Length _____ cm; width _____ cm. Multiply to find the area in square centimetres. _____ cm x _____ cm = _____ cm^2. How close are the answers you have in 6. and in 7.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE CENTIMETRES

You are now ready to develop your ability to estimate in square centimetres.

Remember the size of a square centimetre. For each of the following items, follow the procedures used for estimating in metres.

		Estimate (cm^2)	Measurement (cm^2)	How Close Were You?
1.	Index card.	_____	_____	_____
2.	Book cover.	_____	_____	_____
3.	Photograph.	_____	_____	_____
4.	Window pane or desk top.	_____	_____	_____

II. THE SQUARE METRE (m^2)

A. DEVELOP A FEELING FOR A SQUARE METRE

1. Tape four metre sticks together to make a square which is one metre long and one metre wide.
2. Hold the square up with one side on the floor to see how big it is.
3. Place the square on the floor in a corner. Step back and look. See how much floor space it covers.
4. Place the square over a table top or desk to see how much space it covers.
5. Place the square against the bottom of a door. See how much of the door it covers. How many squares would it take to cover the door? _____m^2

   THIS IS HOW BIG A SQUARE METRE IS!

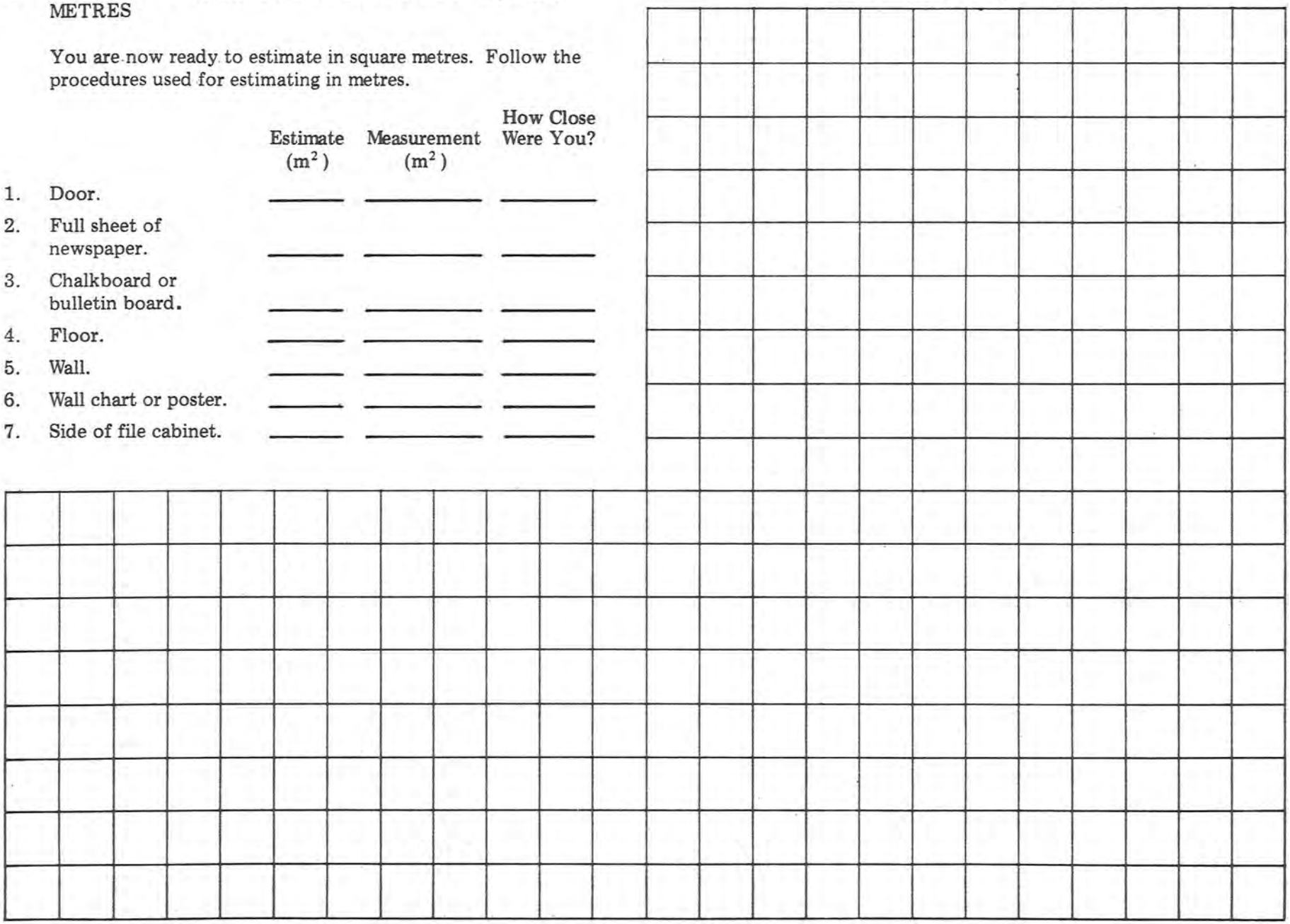
(continued on next page)

B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE METRES

You are now ready to estimate in square metres. Follow the procedures used for estimating in metres.

		Estimate (m^2)	Measurement (m^2)	How Close Were You?
1.	Door.	_____	_____	_____
2.	Full sheet of newspaper.	_____	_____	_____
3.	Chalkboard or bulletin board.	_____	_____	_____
4.	Floor.	_____	_____	_____
5.	Wall.	_____	_____	_____
6.	Wall chart or poster.	_____	_____	_____
7.	Side of file cabinet.	_____	_____	_____

CENTIMETRE GRID



VOLUME MEASUREMENT ACTIVITIES

Cubic Centimetre, Litre, Millilitre, Cubic Metre

I. THE CUBIC CENTIMETRE (cm^3)

A. DEVELOP A FEELING FOR THE CUBIC CENTIMETRE

1. Pick up a colored plastic cube. Measure its length, height, and width in centimetres.

   THAT IS ONE CUBIC CENTIMETRE!

2. Find the volume of a plastic litre box.

   a. Place a ROW of cubes against the bottom of one side of the box. How many cubes fit in the row?_____

   b. Place another ROW of cubes against an adjoining side of the box. How many rows fit inside the box to make one layer of cubes?_____

   How many cubes in each row?_____

   How many cubes in the layer in the bottom of the box?_____

   c. Stand a ROW of cubes up against the side of the box. How many LAYERS would fit in the box?_____

   How many cubes in each layer?_____

   How many cubes fit in the box altogether?_____

   THE VOLUME OF THE BOX IS _____CUBIC CENTIMETRES.

   d. Measure the length, width, and height of the box in centimetres. Length _____ cm; width _____cm; height _____cm. Multiply these numbers to find the volume in cubic centimetres.

   _____cm x _____cm x _____cm = _____cm^3. Are the answers the same in c. and d.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC CENTIMETRES

You are now ready to develop your ability to estimate in cubic centimetres.

Remember the size of a cubic centimetre. For each of the following items, use the procedures for estimating in metres.

		Estimate (cm^3)	Measurement (cm^3)	How Close Were You?
1.	Index card file box.	_____	_____	_____
2.	Freezer container.	_____	_____	_____
3.	Paper clip box.	_____	_____	_____
4.	Box of staples.	_____	_____	_____

II. THE LITRE (l)

A. DEVELOP A FEELING FOR A LITRE

1. Take a one litre beaker and fill it with water.
2. Pour the water into paper cups, filling each as full as you usually do. How many cups do you fill?

   THAT IS HOW MUCH IS IN ONE LITRE!

3. Fill the litre container with rice.

   THAT IS HOW MUCH IT TAKES TO FILL A ONE LITRE CONTAINER!

(continued on next page)

B. DEVELOP YOUR ABILITY TO ESTIMATE IN LITRES

You are now ready to develop your ability to estimate in litres. To write two and one-half litres, you write 2.5 l, or 2.5 litres. To write one-half litre, you write 0.5 l, or 0.5 litre. To write two and three-fourths litres, you write 2.75 l, or 2.75 litres.

For each of the following items, use the procedures for estimating in metres.

		Estimate (l)	Measurement (l)	How Close Were You?
1.	Medium-size freezer container.	_____	_____	_____
2.	Large freezer container.	_____	_____	_____
3.	Small freezer container.	_____	_____	_____
4.	Bottle or jug.	_____	_____	_____

III. THE MILLILITRE (ml)

There are 1 000 millilitres in one litre. 1 000 ml = 1 litre. Half a litre is 500 millilitres, or 0.5 litre = 500 ml.

A. DEVELOP A FEELING FOR A MILLILITRE

1. Examine a centimetre cube. Anything which holds 1 cm^3 holds 1 ml.
2. Fill a 1 millilitre measuring spoon with rice. Empty the spoon into your hand. Carefully pour the rice into a small pile on a sheet of paper.

   THAT IS HOW MUCH ONE MILLILITRE IS!
3. Fill the 5 ml spoon with rice. Pour the rice into another pile on the sheet of paper.

   THAT IS 5 MILLILITRES, OR ONE TEASPOON!
4. Fill the 15 ml spoon with rice. Pour the rice into a third pile on the paper.

   THAT IS 15 MILLILITRES, OR ONE TABLESPOON!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLILITRES

You are now ready to estimate in millilitres. Follow the procedures used for estimating metres.

		Estimate (ml)	Measurement (ml)	How Close Were You?
1.	Small juice can.	_____	_____	_____
2.	Paper cup or tea cup.	_____	_____	_____
3.	Soft drink can.	_____	_____	_____
4.	Bottle.	_____	_____	_____

IV. THE CUBIC METRE (m^3)

A. DEVELOP A FEELING FOR A CUBIC METRE

1. Place a one metre square on the floor next to the wall.
2. Measure a metre UP the wall.
3. Picture a box that would fit into that space.

   THAT IS THE VOLUME OF ONE CUBIC METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC METRES

For each of the following items, follow the estimating procedures used before.

		Estimate (m^3)	Measurement (m^3)	How Close Were You?
1.	Office desk.	_____	_____	_____
2.	File cabinet.	_____	_____	_____
3.	Small room.	_____	_____	_____

MASS (WEIGHT) MEASUREMENT ACTIVITIES

Kilogram, Gram

The mass of an object is a measure of the amount of matter in the object. This amount is always the same unless you add or subtract some matter from the object. Weight is the term that most people use when they mean mass. The weight of an object is affected by gravity; the mass of an object is not. For example, the weight of a person on earth might be 120 pounds; that same person's weight on the moon would be 20 pounds. This difference is because the pull of gravity on the moon is less than the pull of gravity on earth. A person's mass on the earth and on the moon would be the same. The metric system does not measure weight--it measures mass. We will use the term mass here.

The symbol for gram is g.

The symbol for kilogram is kg.

There are 1 000 grams in one kilogram, or 1 000 g = 1 kg.

Half a kilogram can be written as 500 g,or 0.5 kg.

A quarter of a kilogram can be written as 250 g,or 0.25 kg.

Two and three-fourths kilograms is written as 2.75 kg.

I. THE KILOGRAM (kg)

DEVELOP A FEELING FOR THE MASS OF A KILOGRAM

Using a balance or scale, find the mass of the items on the table. Before you find the mass, notice how heavy the object "feels" and compare it to the reading on the scale or balance.

		Mass (kg)
1.	1 kilogram box.	_____
2.	Textbook.	_____
3.	Bag of sugar.	_____
4.	Package of paper.	_____
5.	Your own mass.	_____

B. DEVELOP YOUR ABILITY TO ESTIMATE IN KILOGRAMS

For the following items ESTIMATE the mass of the object in kilograms, then use the scale or balance to find the exact mass of the object. Write the exact mass in the MEASUREMENT column. Determine how close your estimate is:

		Estimate (kg)	Measurement (kg)	How Close Were You?
1.	Bag of rice.	_____	_____	_____
2.	Bag of nails.	_____	_____	_____
3.	Large purse or briefcase.	_____	_____	_____
4.	Another person.	_____	_____	_____
5.	A few books.	_____	_____	_____

(continued on next page)

II. THE GRAM (g)

A. DEVELOP A FEELING FOR A GRAM

1. Take a colored plastic cube. Hold it in your hand. Shake the cube in your palm as if shaking dice. Feel the pressure on your hand when the cube is in motion, then when it is not in motion.

   THAT IS HOW HEAVY A GRAM IS!

2. Take a second cube and attach it to the first. Shake the cubes in first one hand and then the other hand; rest the cubes near the tips of your fingers, moving your hand up and down.

   THAT IS THE MASS OF TWO GRAMS!

3. Take five cubes in one hand and shake them around.

   THAT IS THE MASS OF FIVE GRAMS!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN GRAMS

You are now ready to improve your ability to estimate in grams. Remember how heavy the 1 gram cube is, how heavy the two gram cubes are, and how heavy the five gram cubes are. For each of the following items, follow the procedures used for estimating in kilograms.

		Estimate (g)	Measurement (g)	How Close Were You?
1.	Two thumbtacks.	_____	_____	_____
2.	Pencil.	_____	_____	_____
3.	Two-page letter and envelope.	_____	_____	_____
4.	Nickel.	_____	_____	_____
5.	Apple.	_____	_____	_____
6.	Package of margarine.	_____	_____	_____

TEMPERATURE MEASUREMENT ACTIVITIES

Degree Celsius

I. DEGREE CELSIUS (°C)

Degree Celsius (°C) is the metric measure for temperature.

A. DEVELOP A FEELING FOR DEGREE CELSIUS

Take a Celsius thermometer. Look at the marks on it.

1. Find 0 degrees.

   WATER FREEZES AT ZERO DEGREES CELSIUS (0°C)

   WATER BOILS AT 100 DEGREES CELSIUS (100°C)

2. Find the temperature of the room. _____ °C. Is the room cool, warm, or about right?
3. Put some hot water from the faucet into a container. Find the temperature. _____ °C. Dip your finger quickly in and out of the water. Is the water very hot, hot, or just warm?
4. Put some cold water in a container with a thermometer. Find the temperature. _____ °C. Dip your finger into the water. Is it cool, cold, or very cold?
5. Bend your arm with the inside of your elbow around the bottom of the thermometer. After about three minutes find the temperature. _____ °C. Your skin temperature is not as high as your body temperature.

   NORMAL BODY TEMPERATURE IS 37 DEGREES CELSIUS (37°C).

   A FEVER IS 39°C.

   A VERY HIGH FEVER IS 40°C.

B. DEVELOP YOUR ABILITY TO ESTIMATE IN DEGREES CELSIUS

For each item, ESTIMATE and write down how many degrees Celsius you think it is. Then measure and write the MEASUREMENT. See how close your estimates and actual measurements are.

		Estimate (°C)	Measurement (°C)	How Close Were You?
1.	Mix some hot and cold water in a container. Dip your finger into the water.	_____	_____	_____
2.	Pour out some of the water. Add some hot water. Dip your finger quickly into the water.	_____	_____	_____
3.	Outdoor temperature.	_____	_____	_____
4.	Sunny window sill.	_____	_____	_____
5.	Mix of ice and water.	_____	_____	_____
6.	Temperature at floor.	_____	_____	_____
7.	Temperature at ceiling.	_____	_____	_____

UNIT 2

OBJECTIVES

The student will recognize, select, and write correctly metric quantities used in job related tasks.

- Given a metric measurement task, select the appropriate metric unit.
- Given a metric measurement task in this occupation, estimate then measure the metric quantity.
- Given a metric quantity, write the measurement correctly using either the symbols or the name of the unit.

SUGGESTED TEACHING SEQUENCE

1. Present or make available Information Sheet 2.
2. Present or make available the information in Tables 1b, 2, and 3. Discuss how to use these tables as reference aides. (Metric prefixes are located in Table 1b. Table 2 is a style reference containing rules for capitalization, punctuation, spacing, spelling, fractions and mathematical operations. It also contains suggestions for writing and typing metric units, terms, and symbols. Table 3 gives the correct spelling of metric units and symbols.)
3. Give the students practice in measuring, selecting, and correctly writing metric units by completing Exercises 6, 7, and 8.
4. Test performance by using Section A of "Testing Metric Abilities."

METRICS IN THE OFFICE

Changeover to the metric system is underway. Large corporations in such areas as transportation, chemicals, information systems, electronics, health equipment and supplies are already using the metric measurements to compete on the world market. The metric system has been used in various parts of the industrial and scientific communities for years. Legislation passed in 1975 authorizes an orderly transition to metric. As business and industry make this changeover, employees will need competency in using metric measurement in job-related tasks.

Business and office workers are more concerned with the correct usage of metric terms and symbols than with actual measurement tasks. They use metric terms to place orders, bill customers, type and proof correspondence.

Paper sizes and weights are changing. Margins are changing to centimetres and millimetres. Postal rate calculations will be based on grams. Business and office students need to learn to pronounce and spell the names of metric units, write the symbols, and use proper metric notation. In addition, they need to be able to recognize the incorrect use of terms; for example, if kilograms of chocolate (half a metric ton) is ordered, instead of 500 grams (about a pound).

TYPE IT METRIC STYLE

1. CAPITALIZATION

1.1 Units

Unit names are typed in lower case except for the unit Celsius. The modifier "degree" in "degree Celsius" is lower case.

Correct:	Incorrect:
metre	METRE
litre	Litre
watt	Watt
degree Celsius	degree celsius

1.2 Symbols

All symbols are typed in lower case except for those units named after people, and for the prefixes mega- , giga- , and tera- .

Correct:	Incorrect:
kg	Kg
m	M
W (James Watt)	w
°C (Anders Celsius)	°c
M (mega -)	m
T (tera -)	t
G (giga -)	g

1.3 Table Headings

Units of measure in a table heading can be typed in either all capitals or all lower case. Do not mix capital and lower case letters in an individual unit of measure.

Correct:	Incorrect:
GRAMS	Grams
litres	Litres

2. PUNCTUATION

2.1 Period

Do not use a period after a metric symbol unless the symbol ends a sentence.

Correct:	Incorrect:
12 cm	12 cm.
350 g	350 g.
90 km/h	90 km./h.
50 ml	50 m.l.

2.2 Semicolon

A semicolon separates numbers in a sequence.

Correct:

61 211.1; 9.2; 0.45

Incorrect:

61 211.1, 9.2, 0.45

2.3 Hyphen

2.3.1 Compound units

Use a hyphen or space to type compound unit names in full.

Correct:	Incorrect:
newton-metre	newton·metre
newton metre	newtonmetre

2.3.2 Prefixes

There is no hyphen or space between a prefix and a unit of measure.

Correct:	Incorrect:
millimetre	milli-metre
kilogram	kilo-gram
megahertz	mega hertz

3. SPACING

3.1 Prefix and Unit Symbols

Do not leave a space between a symbol or name having a prefix.

Correct:	Incorrect:
mm	m m
millimetre	milli metre
kg	k g
kilogram	kilo gram

3.2 Numbers and Symbols

A space is left between a number and a symbol. The symbol for "degree Celsius" can be written with or without a space.

Correct:	Incorrect:
10 ml	10ml
8 m	8m
21°C or 21 °C	21° C

3.3 Grouping Numbers

Numbers that are 1 000 and larger use a space instead of a comma to separate groups of three digits. A space is left after each group of three numbers both to the left and to the right of the decimal point. In a four digit number the space does not have to be used except to align with tabulation.

Correct:	Incorrect:
12 486 g	12,486 g
1.035 26 m	1.03526 m
1025 cm or 1 025 cm	
25 987 m	25 987 m
6 025 m	6025 m
10 340 m	10 340 m
42 352 m	42 352 m

TYPE IT METRIC STYLE

3.4 Decimals

No space is used before or after the decimal point.

Correct:	Incorrect:
56.45 m	56. 45 m
1 964.36 kg	1 964 .36 kg

3.5 Mathematical Signs

Leave a space on each side of mathematical operation signs (multiplication, division, etc.) except within a compound symbol.

Correct:	Incorrect:
2 cm x 4 cm	2 cm x4 cm
8 g + 5 g	8 g+5 g
kg/m^3	kg / m^3
N·m	N · m

4. SPELLING

4.1 "re" or "er"

Both "re" and "er" are correct for the metric terms metre/meter and litre/liter. Whichever spelling you use, use that spelling consistently.

4.2 Plurals

4.2.1 Unit symbols

Do not add an "s" to a symbol to show a plural.

Correct:	Incorrect:
8 cm	8 cms
46 g	46 gs
3 ml	3 mls

4.2.2 Unit names

Unit names are made plural when required.

Correct:	Incorrect:
75 metres	75 metre
2.2 kilograms	2.2 kilogram
3 litres	3 litre

4.2.3 Decimal fractions

Decimal fractions which are one or less are singular. Decimal fractions more than one are always plural.

Correct:	Incorrect:
0.5 gram (five tenths of a gram)	0.5 grams
0.8 metre (eight tenths of a metre)	0.8 metres
2.2 kilograms (two and two tenths kilograms)	2.2 kilogram
25.1 millilitres (25 and one tenth millilitre)	25.1 millilitre

4.3 Double Vowels

The final vowel in a prefix is omitted in megohm, kilohm, and hectare. For all other cases both vowels are retained and pronounced. Do not use a space or hyphen to separate the double vowels.

Correct:	Incorrect:
hectare	hectoare
milliampere	millampere
	milli-ampere
	milli ampere

5. FRACTIONS AND MATHEMATICAL OPERATIONS

5.1 Fractions

5.1.1 Decimals

Decimal notation is preferred for all fractions. However, common fractions with a denominator of 2, 3, 4, or 5 are acceptable.

Correct:	Incorrect:
4.43 km	4 43/100 km
0.375 m	3/8 m
0.75 g or 3/4 g	
1.2 m or 1 1/5 m	

5.1.2 Quantities less than one

In numbers less than one, a "0" precedes the decimal point.

Correct:	Incorrect:
0.46 cm	.46 cm
0.871 g	.871 g
0.75 ml	.75 ml

5.2 Multiplication

5.2.1 Unit symbols

Use a raised dot to indicate symbols for units derived as a product.

Correct:	Incorrect:
N·m (newton-metre)	N-m
Pa·s (pascal second)	Pas

5.2.2 Metric number calculations

Use "x" as a multiplier symbol for calculations. Do not use the "product dot."

Correct:	Incorrect:
6.2 mm x 5	6.2mm·5
120 cm x 10	120 cm·10
72 mm x .01	72 m·01

TYPE IT METRIC STYLE

5.3 Division

Division is indicated by the diagonal (oblique stroke or solidus). Only one diagonal should be used in a compound unit of measure.

Correct:	Incorrect:
cm/s	$\frac{cm}{s}$
km/h	$km \div h$

5.4 Powers

5.4.1 Squares and cubes

Use metric symbols with a superscript to indicate area and volume.

Correct:	Incorrect:
55 mm^2	55 sq. mm
10 cm^3	10 cu. cm
3.4 m^2	3.4 sq. m

5.4.2 Scientific notation

Division can also be shown by using a negative exponent.

Example: $m \cdot s^{-1} = m/s$
$km \cdot h^{-1} = km/h$
$m \cdot s^{-2} = m/s^2$

6. OTHER SUGGESTIONS

6.1 Combining Metric Units

Do not combine metric units in one expression.

Correct:	Incorrect:
10.21 m	10 m 20 cm 1 mm
400 cm by 750 cm	400 cm by 7.5 m

6.2 Combining Words and Symbols

Do not combine metric words and symbols in one expression.

Correct:	Incorrect:
kilowatts per hour	kilowatts/h
kW/h	kW/hour

6.3 Prefixes

Use one prefix with a unit of measure.

Correct:	Incorrect:
Mg (megagram)	kkg (kilokilogram)
mm (millimetre)	dcm (decicentimetre)

6.4 Customary and Metric Symbols

Do not combine Customary and metric symbols in the same expression.

Correct:	Incorrect:
kg/m^3	$kg/ft.^3$
ml/m^2	$oz./m^2$

6.5 The Use of "Per"

Use the word "per" when writing out a metric expression. Substitute a diagonal (oblique stroke or solidus) to indicate the word per when writing metric symbols.

Correct:	Incorrect:
kilometres per hour	kilometres/hour
km/h	kph
joule per kilogram	joule/kilogram
J/kg	J per kg

6.6 Typing Suggestions

6.6.1 Typeface

Type metric symbols in upright (roman) type. Use of italic (script) letters should be avoided.

Correct:	Incorrect:
m	*m*

6.6.2 micro - μ

If the symbol μ (mu) is not available, spell out the unit name. If necessary, the symbol can be made by striking the lowercase "u" and adding a tail to the lower left side.

Correct: micrometre μm

6.6.3 ohm - Ω

If the symbol Ω (Omega) is not available, spell out the unit name.

Correct: ohm Ω

6.6.4 litre - l

The symbol for litre is the lowercase "el." This is often confused with the numeral "1" (one). In cases where confusion might exist, spell out the unit name in full.

Correct: 0.5 litre
70 l

Table 2
(continued)

WRITE & SPELL IT RIGHT

Quantity	Unit	Plural	Symbol
length	metre	metres	m
	centimetre	centimetres	cm
	millimetre	millimetres	mm
	kilometre	kilometres	km
area	square metre	square metres	m^2
	square centimetre	square centimetres	cm^2
	square millimetre	square millimetres	mm^2
volume/ capacity	cubic metre	cubic metres	m^3
	cubic centimetre	cubic centimetres	cm^3
	litre	litres	l
	millilitre	millilitres	ml
mass	gram	grams	g
	kilogram	kilograms	kg
	metric ton	metric tons	t
temperature	degree Celsius	degrees Celsius	°C
	kelvin	kelvins	K
time	day	days	d
	hour	hours	h
	minute	minutes	min
	second	seconds	s
velocity	metre per second	metres per second	m/s
frequency	hertz	hertz	Hz
	megahertz	megahertz	MHz

Quantity	Unit	Plural	Symbol
force	newton	newtons	N
conductance	siemens	siemens	S
electric current	ampere	amperes	A
electric change	coulomb	coulombs	C
electric potential	volt	volts	V
electric capacitance	farad	farads	F
electrical resistance	ohm	ohms	Ω
power	watt	watts	W
	kilowatt	kilowatts	kW
energy	joule	joules	J
	kilojoule	kilojoules	kJ
illuminance	lux	lux	lx
luminous intensity	candela	candelas	cd
density	kilogram per cubic metre	kilograms per cubic metre	kg/m^3
pressure/stress	pascal	pascals	Pa
	kilopascal	kilopascals	kPa
amount of substance	mole	moles	mol
luminous flux	lumen	lumens	lm
magnetic flux	weber	webers	Wb
magnetic inductance	tesla	teslas	T
inductance	henry	henries	H

Table 3

TRYING OUT METRIC UNITS

To give you practice with metric units, first estimate the measurements of the items below. Write down your best guess next to the item. Then actually measure the item and write down your answers using the correct metric symbols. The more you practice, the easier it will be.

	Estimate	Actual
Length		
1. Width of file drawer		
2. File folder width		
3. Length of standard paper clip		
4. Width of desk top		
5. Length of table		
6. Length of typing book		
7. Height of the typewriter desk		
8. Width of "a" key on a typewriter		
9. Height of a four-drawer letter file cabinet		
Area		
10. Desk top		
11. Small business card		
12. Sheet of typing paper		
13. Typing book cover		
14. Envelope		
Volume/Capacity		
15. Small file box		
16. Middle desk drawer		
17. File cabinet drawer		
18. Box of rubber bands		
19. Wastebasket		
20. Bottle of typewriter cleaner		
21. Letter size file drawer		
22. Coffee cup		
Mass		
23. Ream of paper		
24. Typing eraser		
25. Paper clip		
26. Dictionary		
27. Business letter in an envelope		
28. Stapler		
Temperature		
29. Room temperature		
30. Outside temperature		
31. Hot tap water		
32. Cold tap water		

USE THOSE METRIC TERMS

It is important to know what metric measurement to use. Show what measurement to use in the following situations.

1. Determining the area of desk top	
2. Measuring the length of desk calendar	
3. Measuring the width of desk calendar	
4. Determining the area of in-out basket	
5. Measuring the length of desk pad	
6. Measuring the width of desk pad	
7. Determining the top margin of a letter	
8. Setting the side margin of a letter	
9. Determining the amount of typewriter cleaner fluid in a bottle	
10. Determining the correct dimensions of a piece of paper	
11. Ordering a box of carbon paper	
12. Determining the width of file folder	
13. Determining the height of file cabinet	
14. Finding the depth of file cabinet	
15. Determining the capacity of file drawer	
16. Ordering a bottle of liquid correction fluid	
17. Determining how much water to put in a coffee pot	
18. Buying rubber cement	
19. Finding the mass of a business letter	
20. Finding the mass of a package of 5 typing books	
21. Buying duplicator fluid	
22. Determining temperature of the office	
23. Adjusting chair to comfortable height	
24. Finding distances for a mileage report	
25. Ordering typing paper	

WRITING METRIC TERMS

1. Using the reference materials, write metric symbols for the following:

a) 900 farads _____
b) 46 teslas _____
c) 9 webers _____
d) 465 metres _____
e) 900 kilolitres _____
f) 649 micrograms _____
g) 41 megavolts _____
h) 28 centimetres _____
i) 981 lumens _____
j) 968 cubic millimetres _____
k) 1 square metre _____
l) 465 metric tons _____
m) 90 kilometres per hour _____
n) 14 hours _____
o) 76 degrees Celsius _____

2. Using the reference materials, write the numeral and write out the metric term for each of the following:

a) 975 cm^3 _____
b) 841 l _____
c) 91 mm _____
d) 47 μg _____
e) 418 T _____
f) 46 N·m _____
g) 78 Wb/m^2 _____
h) 14 m^3 _____
i) 871 ml _____
j) 94 g _____
k) 853 kPa _____
l) 95°C _____
m) 461 V _____
n) 978 Tm _____
o) 81 kl _____

3. Write the metric symbol for the metric words that are written out, and write the metric words in full for the metric symbols that are given. Use Tables 1b, 2, and 3 as a guide, if necessary.

a) Paper width, 210 millimetres _____
b) Stapler mass, 400 grams _____
c) Bookshelf width, 97 centimetres _____
d) File cabinet height, 1.5 metres _____
e) Cooler of water, 5 litres _____
f) Dictionary cover area, 450 square centimetres _____
g) Volume of 1 cup of coffee, 215 millilitres _____
h) Typing book mass, 1 kilogram _____
i) Eraser, 50 mm _____
j) Desk drawer area, 10 880 cm^3 _____
k) 500 ml of coffee _____
l) Room temperature, 22°C _____
m) Mass of a paper clip, 0.5 g _____
n) Height of one book-shelf, 30 cm _____
o) Room length, 10 m _____
p) Duplicator fluid, 4 l _____

UNIT 3

OBJECTIVE

The student will recognize and use metric equivalents.

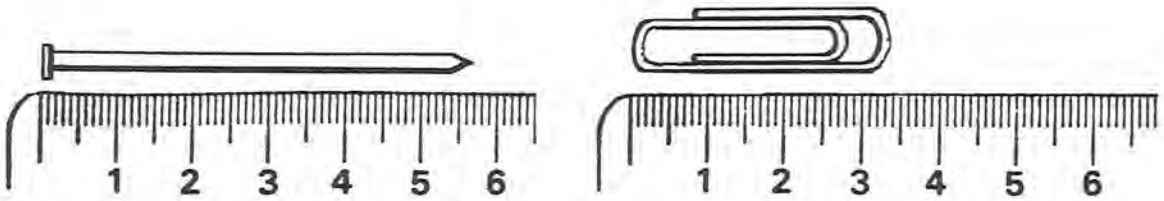
- Given a metric unit, state an equivalent in a larger or smaller metric unit.

SUGGESTED TEACHING SEQUENCE

1. Make available the Information Sheets (3 - 8) and the associated Exercises (9 - 15), one at a time.
2. As soon as you have presented the Information, have the students complete each Exercise.
3. Check their answers on the page titled ANSWERS TO EXERCISES AND TEST.
4. Test performance by using Section B of "Testing Metric Abilities."

METRIC-METRIC EQUIVALENTS

Centimetres and Millimetres



Look at the picture of the nail next to the ruler. The nail is 57 mm long. This is 5 cm + 7 mm. There are 10 mm in each cm, so 1 mm = 0.1 cm (one-tenth of a centimetre). This means that 7 mm = 0.7 cm, so 57 mm = 5 cm + 7 mm
= 5 cm + 0.7 cm
= 5.7 cm. Therefore 57 mm is the same as 5.7 cm.

Now measure the paper clip. It is 34 mm. This is the same as 3 cm + _____mm. Since each millimetre is 0.1 cm (one-tenth of a centimetre), 4 mm = _____cm. So, the paper clip is 34 mm = 3 cm + 4 mm
= 3 cm + 0.4 cm
= 3.4 cm. This means that 34 mm is the same as 3.4 cm.

Information Sheet 3

Now you try some.

a) 26 mm = _____ cm
b) 583 mm = _____ cm
c) 94 mm = _____ cm
d) 680 mm = _____ cm
e) 132 mm = _____ cm
f) 802 mm = _____ cm
g) 1 400 mm = _____ cm
h) 2 307 mm = _____ cm

Exercise 9

Metres, Centimetres, and Millimetres

There are 100 centimetres in one metre. Thus,

2 m = 2 x 100 cm = 200 cm,
3 m = 3 x 100 cm = 300 cm,
8 m = 8 x 100 cm = 800 cm,
36 m = 36 x 100 cm = 3 600 cm.

There are 1 000 millimetres in one metre, so

2 m = 2 x 1 000 mm = 2 000 mm,
3 m = 3 x 1 000 mm = 3 000 mm,
6 m = 6 x 1 000 mm = 6 000 mm,
24 m = 24 x 1 000 mm = 24 000 mm.

From your work with decimals you should know that

one-half of a metre can be written 0.5 m (five-tenths of a metre),
one-fourth of a centimetre can be written 0.25 cm
(twenty-five hundredths of a centimetre).

This means that if you want to change three-fourths of a metre to millimetres, you would multiply by 1 000. So

$0.75 \text{ m} = 0.75 \times 1\,000 \text{ mm}$

$= \frac{75}{100} \times 1\,000 \text{ mm}$

$= 75 \times \frac{1\,000}{100} \text{ mm}$

$= 75 \times 10 \text{ mm}$

= 750 mm. This means that 0.75 m = 750 mm.

Information Sheet 4

Fill in the following chart.

metre m	centimetre cm	millimetre mm
1	100	1 000
2	200	
3		
9		
		5 000
74		
0.8	80	
0.6		600
	2.5	25
		148
	639	

Exercise 10

Millilitres to Litres

There are 1 000 millilitres in one litre. This means that

2 000 millilitres is the same as 2 litres,
3 000 ml is the same as 3 litres,
4 000 ml is the same as 4 litres,
12 000 ml is the same as 12 litres.

Since there are 1 000 millilitres in each litre, one way to change millilitres to litres is to divide by 1 000. For example,

Or $1\,000 \text{ ml} = \frac{1\,000}{1\,000} \text{ litre} = 1 \text{ litre}.$

$2\,000 \text{ ml} = \frac{2\,000}{1\,000} \text{ litres} = 2 \text{ litres}.$

And, as a final example,

$28\,000 \text{ ml} = \frac{28\,000}{1\,000} \text{ litres} = 28 \text{ litres}.$

What if something holds 500 ml? How many litres is this? This is worked the same way.

$500 \text{ ml} = \frac{500}{1\,000}$ litre = 0.5 litre (five-tenths of a litre). So 500 ml is the same as one-half (0.5) of a litre.

Change 57 millilitres to litres.

$57 \text{ ml} = \frac{57}{1\,000}$ litre = 0.057 litre (fifty-seven thousandths of a litre).

Information Sheet 5

Now you try some. Complete the following chart.

millilitres (ml)	litres (l)
3 000	3
6 000	
	8
14 000	
	23
300	0.3
700	
	0.9
250	
	0.47
275	

Exercise 11

Litres to Millilitres

What do you do if you need to change litres to millilitres? Remember, there are 1 000 millilitres in one litre, or 1 litre = 1 000 ml.

So,

2 litres = 2 x 1 000 ml = 2 000 ml,
7 litres = 7 x 1 000 ml = 7 000 ml,
13 litres = 13 x 1 000 ml = 13 000 ml,
0.65 litre = 0.65 x 1 000 ml = 650 ml.

Information Sheet 6

Now you try some. Complete the following chart.

litres l	millilitres ml
8	8 000
5	
46	
	32 000
0.4	
0.53	
	480

Exercise 12

Grams to Kilograms

There are 1 000 grams in one kilogram. This means that

2 000 grams is the same as 2 kilograms,

5 000 g is the same as 5 kg,

700 g is the same as 0.7 kg, and so on.

To change from grams to kilograms, you use the same procedure for changing from millilitres to litres.

Information Sheet 7

Try the following ones.

grams g	kilograms kg
4 000	4
9 000	
23 000	
	8
300	
275	

Exercise 13

Kilograms to Grams

To change kilograms to grams, you multiply by 1 000.

4 kg = 4 x 1 000 g = 4 000 g,
23 kg = 23 x 1 000 g = 23 000 g,
0.75 kg = 0.75 x 1 000 g = 750 g.

Information Sheet 8

Complete the following chart.

kilograms kg	grams g
7	7 000
11	
	25 000
0.4	
0.63	
	175

Exercise 14

Changing Units at Work

Some of the things you use in this occupation may be measured in different metric units. Practice changing each of the following to metric equivalents by completing these statements.

a) 500 cm of tape is _____ m
b) 250 ml of solution is _____ l
c) 2 cm stamp is _____ mm
d) 500 g of mimeograph ink is _____ kg
e) 0.05 litre of fluid is _____ ml
f) 1.5 m file cabinet is _____ mm
g) 2 500 g package is _____ kg
h) 24 cm side margin is _____ mm
i) 500 ml of fluid is _____ l
j) 0.5 t of paper is _____ kg
k) 10 m of twine is _____ cm
l) 3.5 cm paper clip is _____ mm
m) 20 kg typewriter is _____ g
n) 25 cm wide envelope is _____ mm
o) 2 400 mm room divider length is _____ cm

Exercise 15

UNIT 4

OBJECTIVES

The student will correctly proof, type, layout pages, and take dictation using metric units, terms, and symbols.

- Given a proofing exercise with metric terms, identify the incorrect usage of terms and symbols, and correctly type the exercise using proper rules of notation.
- Given layout information and metric dimensions, prepare an attractive typing layout for a page.
- Given a dictation exercise correctly take notes in shorthand and type the metric units, terms, and symbols using proper rules of notation.

SUGGESTED TEACHING SEQUENCE

1. Present or make available Information Sheet 9 and Tables 1b, 2, and 3. Review the reference format and ways of using the reference material.
2. Using the references, have students complete the proofing and typing exercises in Exercise 16.
3. Assemble equipment (paper, rulers, scissors, etc.) and have students complete the layouts in Exercise 17.
4. Dictate 30 metric terms and a brief passage containing metric terms and symbols for Exercise 18 on dictating equipment. Discuss the implications of metric terms in shorthand tasks. Have students take notes in shorthand, then transcribe and type a final copy from their notes.

WORKING WITH METRICS

TYPING

The American Metric Council recommends when the following metric symbols are used frequently that they be included on typewriters:

1. superscripts ^{2} and ^{3} for squares and cubes
2. sign · for a product dog
3. symbol $^\circ$ for degree
4. symbol Ω for ohm
5. symbol μ for micro

A special type element is available for some typewriters which contains these and many other characters used in technical reports. Other typewriters can use replaceable character keys.

If neither of these options is available the following procedures can be used on regular keyboards. Superscripts, product dots, and degree symbols can be produced by rolling the platen half a space before typing the figure. Numerals are typed as superscripts, the period is substituted for the product dot and a lower case "o" is typed for the degree symbol. "Ohm" (Ω) should be spelled out whenever possible. Micro (μ) can be produced by striking a lower case "u" and adding a tail to the lower left side.

LAYOUT AND MARGINS

Layout designs and margins will be given in millimetres and centimetres. 2.5 cm will be used instead of 1 inch margins, 3.75 cm for 1 1/2 inches, 5 cm for 2 inches, etc.

SHORTHAND

No specific rules for writing metric terms in shorthand have yet been established. Some stenographers may find it easier to write the metric symbols than the shorthand forms. However, some suggested Gregg shorthand brief forms are located with Exercise 18.

PROOFREADING METRIC TERMS

Part 1. Type the following memo. Be sure to proof it before you begin typing. (There are spelling, symbol, and notation errors.) Prepare a final mailable copy.

To: All Staff Date: December 14, 19--
From: Paul Jones, President Subject: Adoption of Metric System

Due to the recent adoption of the metric system by the United States Government, we find some need to expand this company's background knowledge of the system. We will be required to order more of our equipment and supplies utilizing the metric unit of measure. Also, our customers will gradually begin to order in metric quantities. Therefore, we must prepare to meet this challenge. Please review the following information and keep it available for easy reference.

1. Linear measures will be: millimetres (mM) and centimeters (cm.) instead of inches; metres (M) will replace feet and yards; kilometres will take the place of miles. Travel reports will reflect Km rather than miles. Speed will be recorded in km per hour rather than mph.
2. Area is measured by cm^2 replacing square inches: square feet and square yards will be replaced by m^2. The unit of land measure which replaces the acre will be the hectare.
3. Liquid supplies will be measured in millimetres (ml) and litres (L) (replacing the cup, pint, quart, gallon); and very large quantities will be measured in killolitres (kls).
4. Weights will be determined in grammes, kilograms, and tonnes.
5. A comfortable room temperature will be 20 degrees Celisus (20° C) instead of 68°F. Also, scientific use of temperature will be shown in Kelvins.
6. The following electrical terms will not change: voltes (v.), henries (H), webres (wb), farades (F), and Wats (Ws), etc.

Training programs will be scheduled for all employees in the very near future. Let's go metric!

Paul Jones

Part 2.

Proof the following advertisement. There are spelling, symbol, notation, and substitution errors. Type a final printable copy.

FOR SALE

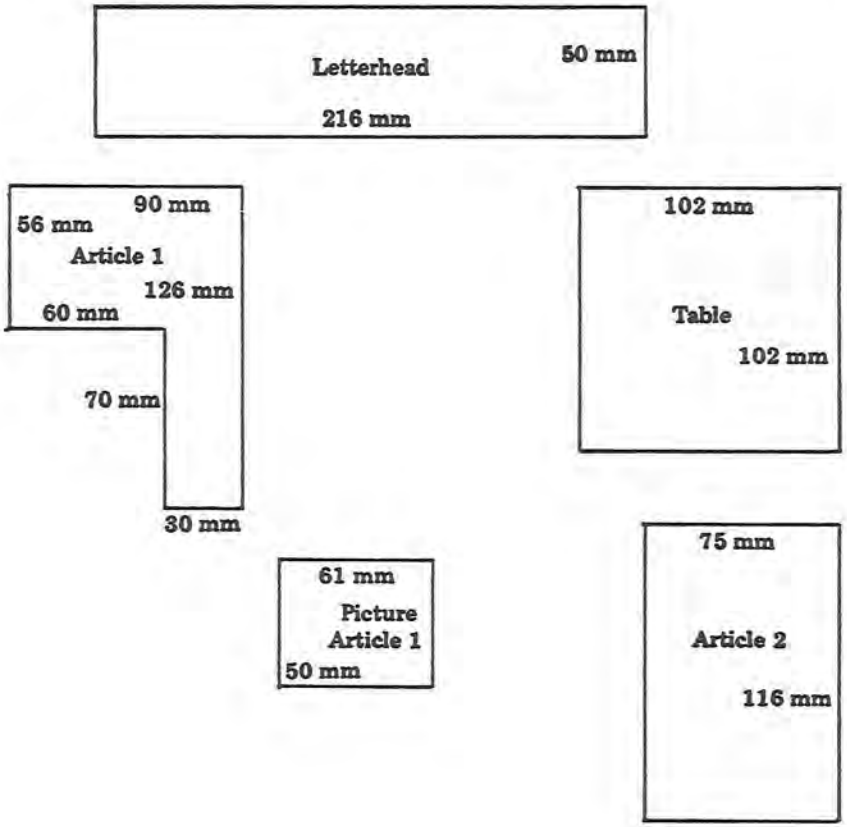
Lovely old colonial home located on wooded ten-Hectare lot in Worthmoore school district, just 10 Km from the nearest shoping centre. The house has 225 sq. m. of floor space; a large 400 cms x 730cm livingroom; formal 335 Cm x 430 centilitre dining room; three bedrooms; two full baths; finished basement; and seperate two-car garage. It has a 250 liter water heater, 400 Litre fuel oil tank, and 15 cms of insulation in the attic.

Special features: two wood burning fireplaces with 4 ms^3 of cut wood; wine cellar kept at constant 12° C; 4-stall stable with 500 Kg of feed; 25 M^2 of formal garden; 4 kiloliter of riding trails; 2 hectare of woods; 1 1/2 hA fenced pasture; .75 km driveway bordered by a stone fense 1 3/8 m high.

For information call Metric Realty at 466-4874, Ext. 2.

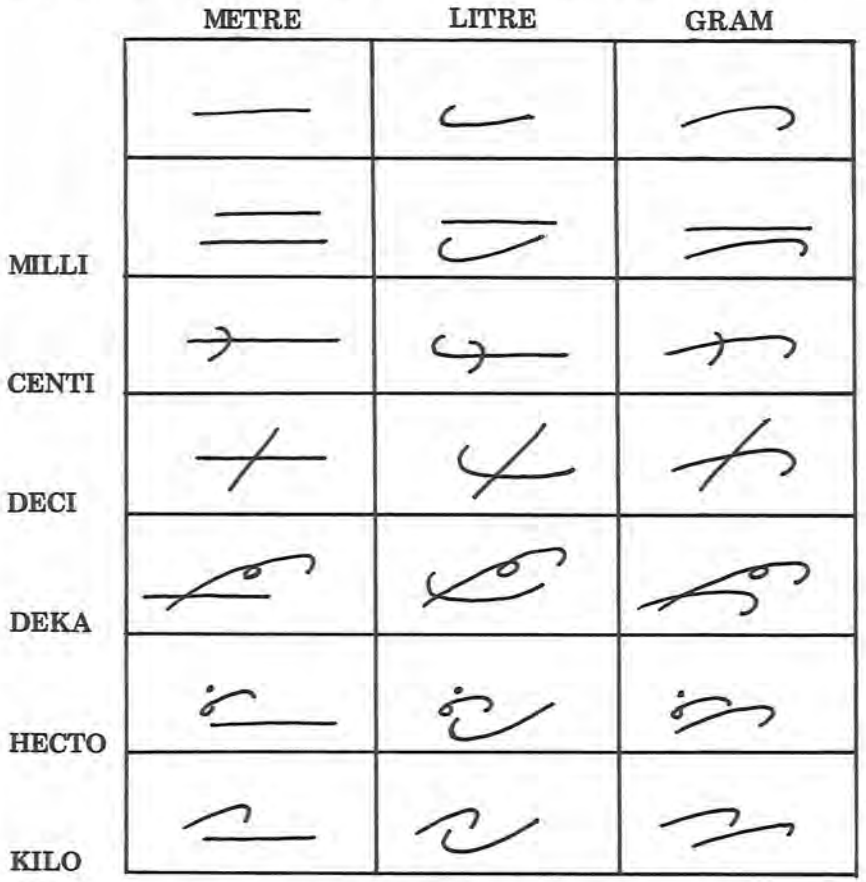
METRIC LAYOUTS

You have been given the following information for a layout for typing. Your task is to prepare correct sizes of the items and plan an attractive layout for the page. (The figures shown below are the actual measurements you are to use; however, the drawings are scaled down to one third that size.)



METRIC SHORTHAND

Shorthand will have to accommodate the new terms which the metric system will introduce. Some possible Gregg Shorthand brief forms for the metric terms may include the following; however, check with textbook publishing companies for the latest decisions.



1. Take 30 metric terms in shorthand. Transcribe the terms from your notes, being careful to spell terms and use symbols correctly.

2. Take dictation that contains metric terms and symbols.

*Information and chart adapted from service project report "The Metric System and its Impact on Business Education" by Delta Pi Epsilon, Beta Mu Chapter, Central Connecticut State College, New Britain, Connecticut, November 1976.

UNIT 5

OBJECTIVE

The student will recognize and use metric and Customary units interchangeably in ordering, selling, and using products and supplies in this occupation.

- Given a Customary (or metric) measurement, find the metric (or Customary) equivalent on a conversion table.
- Given a Customary unit, state the replacement unit.

SUGGESTED TEACHING SEQUENCE

1. Assemble packages and containers of materials.
2. Present or make available Information Sheet 10.
3. Have students find approximate metric-Customary equivalents by using Exercise 19.
4. Test performance by using Section D of "Testing Metric Abilities."

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METRIC-CUSTOMARY EQUIVALENTS

During the transition period there will be a need for finding equivalents between systems. Conversion tables list calculated equivalents between the two systems. When a close equivalent is needed, a conversion table can be used to find it. Follow these steps:

1. Determine which conversion table is needed.
2. Look up the known number in the appropriate column; if not listed, find numbers you can add together to make the total of the known number.
3. Read the equivalent(s) from the next column.

Below is a table of metric-Customary equivalents which tells you what the metric replacements for Customary units are.* This table can be used with Exercise 19, Part 1. The symbol ≈ means "nearly equal to."

1 cm ≈ 0.39 inch	1 inch ≈ 2.54 cm	1 ml ≈ 0.2 tsp	1 tsp ≈ 5 ml
1 m ≈ 3.28 feet	1 foot ≈ 0.305 m	1 ml ≈ 0.07 tbsp	1 tbsp ≈ 15 ml
1 m ≈ 1.09 yards	1 yard ≈ 0.91 m	1 l ≈ 33.8 fl oz	1 fl oz ≈ 29.6 ml
1 km ≈ 0.62 mile	1 mile ≈ 1.61 km	1 l ≈ 4.2 cups	1 cup ≈ 237 ml
1 cm^2 ≈ 0.16 sq in	1 sq in ≈ 6.5 cm^2	1 l ≈ 2.1 pts	1 pt ≈ 0.47 l
1 m^2 ≈ 10.8 sq ft	1 sq ft ≈ 0.09 m^2	1 l ≈ 1.06 qt	1 qt ≈ 0.95 l
1 m^2 ≈ 1.2 sq yd	1 sq yd ≈ 0.8 m^2	1 l ≈ 0.26 gal	1 gal ≈ 3.79 l
1 hectare ≈ 2.5 acres	1 acre ≈ 0.4 hectare	1 gram ≈ 0.035 oz	1 oz ≈ 28.3 g
1 cm^3 ≈ 0.06 cu in	1 cu in ≈ 16.4 cm^3	1 kg ≈ 2.2 lb	1 lb ≈ 0.45 kg
1 m^3 ≈ 35.3 cu ft	1 cu ft ≈ 0.03 m^3	1 metric ton ≈ 2205 lb	1 ton ≈ 907.2 kg
1 m^3 ≈ 1.3 cu yd	1 cu yd ≈ 0.8 m^3	1 kPa ≈ 0.145 psi	1 psi ≈ 6.895 kPa

*Adapted from *Let's Measure Metric. A Teacher's Introduction to Metric Measurement.* Division of Educational Redesign and Renewal, Ohio Department of Education, 65 S. Front Street, Columbus, OH 43215, 1975.

ANY WAY YOU WANT IT

1. One of your office tasks may be typing purchase orders, making changes from Customary units to metric units of measure (as some suppliers will sell metric quantities only). To develop your skill in determining approximate Customary equivalents, use the Table on Information Sheet 10 and give the approximate metric quantity (both number and units) for each of the following Customary quantities.

	Customary Quantity	Metric Quantity
a)	1 gal. of typewriter cleaner	
b)	5 oz. of correction fluid	
c)	1/2 in. tape	
d)	2 lbs. of hand cleaner	
e)	25 ft. of string	
f)	9 in. reference manual	
g)	Two-gallon waste basket	
h)	1 pt. of hand cleaner	
i)	1/2 lb. of rubber bands	
j)	30 in. x 60 in. desk	
k)	1 fl. oz. liquid re-type	
l)	5 lb. package	
m)	6 in. pair of scissors	
n)	3 mile distance	

MILLIMETRES TO INCHES

mm	in.	mm	in.
10	0.39	1	0.04
20	0.79	2	0.08
30	1.18	3	0.12
40	1.57	4	0.16
50	1.97	5	0.20
60	2.36	6	0.24
70	2.76	7	0.28
80	3.15	8	0.31
90	3.54	9	0.35

INCHES TO MILLIMETRES

in.	mm	in.	mm
10	254.0	1	25.4
20	508.0	2	50.8
30	762.0	3	76.2
40	1016.0	4	101.6
50	1270.0	5	127.0
60	1524.0	6	152.4
70	1778.0	7	177.8
80	2032.0	8	203.2
90	2286.0	9	228.6

2. Use the following conversion tables to find the metric or Customary equivalent for these quantities.

a) 1 mm = _____
b) 45 mm = _____
c) 25 mm = _____
d) 83 mm = _____
e) 54 mm = _____
f) 72 mm = _____
g) 11 mm = _____
h) 60 mm = _____
i) 22 mm = _____
j) 8 mm = _____
k) 24 mm = _____
l) 75 mm = _____
m) 15 in. = _____
n) 5 in. = _____
o) 2 in. = _____
p) 18 in. = _____
q) 35 in. = _____
r) 12 in. = _____
s) 7 in. = _____
t) 25 in. = _____
u) 11 in. = _____
v) 8 in. = _____
w) 6 in. = _____
x) 35 in. = _____

SECTION A

1. One kilogram is about the mass of a:
   [A] nickel
   [B] apple seed
   [C] basketball
   [D] Volkswagen "Beetle"

2. A square metre is about the area of:
   [A] this sheet of paper
   [B] a card table top
   [C] a bedspread
   [D] a postage stamp

3. When setting side margins, the unit of measure would be:
   [A] metre
   [B] millilitre
   [C] centimetre
   [D] kilometre

4. When finding the mass of a package, the unit of measure would be:
   [A] lux
   [B] litres
   [C] amperes
   [D] grams

5. The correct way to write twenty grams is:
   [A] 20 gms
   [B] 20 Gm.
   [C] 20 g.
   [D] 20 g

6. The correct way to write twelve thousand millimetres is:
   [A] 12,000 mm.
   [B] 12.000 mm
   [C] 12 000mm
   [D] 12 000 mm

SECTION B

7. A paper 216 millimetres wide also has a width of:
   [A] 21.6 metres
   [B] 21.6 centimetres
   [C] 0.216 metre
   [D] 2.16 centimetres

8. The mass of a package is 1 000 grams or:
   [A] 1 kilogram
   [B] 100 kilograms
   [C] 10 kilograms
   [D] 0.1 kilogram

SECTION C

9. Which metric term is misspelled?
   [A] joule
   [B] pascels
   [C] ampere
   [D] lumens

10. Which sentence is correctly typed?
    [A] The hand cleaner is 178 gs.
    [B] The mass of the package is 28 g.
    [C] The paper is 216mm x28lmm.
    [D] The car traveled 80 k/hour.

11. Which metric term is misspelled?
    [A] webers
    [B] ampers
    [C] metric ton
    [D] microgram

12. The correct way to write kilometres per hour is:
    [A] k.p.h.
    [B] km/h
    [C] k/hr
    [D] kilometres/hour

SECTION D

13. The replacement unit for fluid ounces is:
    [A] grams
    [B] litres
    [C] millilitres
    [D] milligrams

14. The replacement unit for feet is:
    [A] litres
    [B] millilitres
    [C] millimetres
    [D] metres

Use this conversion table to answer questions 15 and 16.

mm	in.	mm	in.
100	3.94	10	0.39
200	7.87	20	0.79
300	11.81	30	1.18
400	15.74	40	1.57
500	19.68	50	1.97
600	23.62	60	2.36
700	27.56	70	2.76
800	31.50	80	3.15
900	35.43	90	3.54

15. The equivalent for 150 mm is:
    [A] 15.0 in.
    [B] 5.0 in.
    [C] 1.50 in.
    [D] 5.91 in.

16. The equivalent for 210 mm is:
    [A] 20.0 in.
    [B] 8.26 in.
    [C] 8.0 in.
    [D] 20.26 in.

ANSWERS TO EXERCISES AND TEST

EXERCISES 1 THRU 6

The answers depend on the items used for the activities.

EXERCISE 7

Currently accepted metric units of measurement for each question are shown in Table 1a. Standards in each occupation are being established now, so answers may vary.

EXERCISE 8

Part 1.

a) 900 F
b) 46 T
c) 9 Wb
d) 465 m
e) 900 kl
f) 649 μg
g) 41 MV
h) 28 cm
i) 981 lm
j) 968 mm^3
k) 1 m^2
l) 465 t
m) 90 km/h
n) 14 h
o) 76°C

Part 2.

a) 975 cubic centimetres
b) 841 litres
c) 91 millimetres
d) 47 micrograms
e) 418 teslas
f) 46 newton-metres or 46 newton metres
g) 78 webers per square metre
h) 14 cubic metres
i) 871 millilitres
j) 94 grams
k) 853 kilopascals
l) 95 degrees Celsius
m) 461 volts
n) 978 terametres
o) 81 kilolitres

Part 3.

a) 210 mm
b) 400 g
c) 97 cm
d) 1.5 m
e) 5 l
f) 450 cm^2
g) 215 ml
h) 1 kg
i) 50 millimetres
j) 10 880 cubic centimetres
k) 500 millilitres
l) 22 degrees Celsius
m) 0.5 gram
n) 30 centimetres
o) 10 metres
p) 4 litres

EXERCISE 9

a) 2.6 cm
b) 58.3 cm
c) 9.4 cm
d) 68.0 cm
e) 13.2 cm
f) 80.2 cm
g) 140.0 cm
h) 230.7 cm

EXERCISES 10 THRU 14

Tables are reproduced in total. Answers are in parentheses.

Exercise 10

metre m	centimetre cm	millimetre mm
1	100	1 000
2	200	(2 000)
3	(300)	(3 000)
9	(900)	(9 000)
(5)	(500)	5 000
74	(7 400)	(74 000)
0.8	80	(800)
0.6	(60)	600
(0.025)	2.5	25
(0.148)	(14.8)	148
(6.39)	639	(6 390)

Exercise 11

millilitres ml	litres l
3 000	3
6 000	(6)
(8 000)	8
(14 000)	(14)
(23 000)	23
300	0.3
700	(0.7)
(900)	0.9
250	(0.25)
(470)	0.47
275	(0.275)

Exercise 12

litres l	millilitres ml
8	8 000
5	(5 000)
46	(46 000)
(32)	32 000
0.4	(400)
0.53	(530)
(0.48)	480

Exercise 13

grams g	kilograms kg
4 000	4
9 000	(9)
23 000	(23)
(8 000)	8
300	(0.3)
275	(0.275)

Exercise 14

kilograms kg	grams g
7	7 000
11	(11 000)
(25)	25 000
0.4	(400)
0.63	(630)
(0.175)	175

EXERCISE 15

a)	5 m	i)	0.5 litre
b)	0.25 litre	j)	500 kg
c)	20 mm	k)	1 000 cm
d)	0.5 kg	l)	35 mm
e)	50 ml	m)	20 000 g
f)	1 500 mm	n)	250 mm
g)	2.5 kg	o)	240 cm
h)	240 mm		

EXERCISE 16

The correct answers are underlined in the following copy.

Part 1.

1. Linear measures will be: millimetres (mm) and centimetres (cm) instead of inches; metres (m) will replace feet and yards; kilometres will take the place of miles. Travel reports will reflect km rather than miles. Speed will be recorded in km/h rather than mph.

2. Area is measured by cm^2 replacing square inches; square feet and square yards will be replaced by m^2. The unit of land measure which replaces the acre will be the hectare.

3. Liquid supplies will be measured in millilitres (ml) and litres (l), replacing the cup, pint, quart, gallon; and very large quantities will be measured in kilolitres (kl).

4. Weights will be determined in grams, kilograms, and metric tons.

5. A comfortable room temperature will be 20 degrees Celsius (20°C) instead of 68°F. Also, scientific use of temperature will be shown in kelvins.

6. The following electrical terms will not change: volts (V), henries (H), webers (Wb), farads (F), and watts (W), etc.

Part 2.

Lovely old colonial home located on wooded ten-hectare lot in Worthmoore school district, just 10 km from the nearest shopping center. The house has 225 m^2 of floor space; a large 400 cm x 730 cm living room; formal 335 cm x 430 cm dining room; three bedrooms; two full baths; finished basement; and separate two-car garage. It has a 250 litre water heater, 400 litre fuel oil tank, and 15 cm of insulation in the attic.

Special features: 2 wood burning fireplaces with 4 m^3 of cut wood; wine cellar kept at constant 12°C; 4-stall stable with 500 kg of feed; 25 m^2 of formal garden; 4 kilometres of riding trails; 2 hectares of woods; 1.5 ha fenced pasture; 0.75 km driveway bordered by a stone fence 1.375 m high.

EXERCISE 17

Teacher to determine criteria for attractive layout.

EXERCISE 18

The answers depend on the terms dictated.

EXERCISE 19

Part 1.

a)	3.79 litres	h)	0.47 litre
b)	148 ml	i)	0.225 kg
c)	1.27 cm	j)	76.2 cm x 152.4 cm
d)	0.9 kg	k)	29.6 ml
e)	7.625 m	l)	2.25 kg
f)	22.86 cm	m)	15.24 cm
g)	7.58 litres	n)	4.83 km

Part 2.

a)	0.04 in.	m)	381 mm
b)	1.77 in.	n)	127 mm
c)	0.99 in.	o)	50.8 mm
d)	3.27 in.	p)	45.72 mm
e)	2.13 in.	q)	889 mm
f)	2.84 in.	r)	304.8 mm
g)	0.43 in.	s)	177.8 mm
h)	2.36 in.	t)	635 mm
i)	0.87 in.	u)	279.4 mm
j)	0.31 in.	v)	203.2 mm
k)	0.95 in.	w)	152.4 mm
l)	2.96 in.	x)	914.4 mm

TESTING METRIC ABILITIES

1.	C	9.	B
2.	B	10.	B
3.	C	11.	B
4.	D	12.	B
5.	D	13.	C
6.	D	14.	D
7.	B	15.	D
8.	A	16.	B

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SUGGESTED METRIC TOOLS AND DEVICES
NEEDED TO COMPLETE MEASUREMENT TASKS
IN EXERCISES 1 THROUGH 5
(* Optional)

LINEAR

- Metre Sticks
- Rules, 30 cm
- Measuring Tapes, 150 cm
- *Height Measure
- *Metre Tape, 10 m
- *Trundle Wheel
- *Area Measuring Grid

VOLUME/CAPACITY

- *Nesting Measures, set of 5, 50 ml - 1 000 ml
- Economy Beaker, set of 6, 50 ml - 1 000 ml
- Metric Spoon, set of 5, 1 ml - 25 ml
- Dry Measure, set of 3, 50, 125, 250 ml
- Plastic Litre Box
- Centimetre Cubes

MASS

- Bathroom Scale
- *Kilogram Scale
- *Platform Spring Scale
  - 5 kg Capacity
  - 10 kg Capacity
- Balance Scale with 8-piece mass set
- *Spring Scale, 6 kg Capacity

TEMPERATURE

- Celsius Thermometer

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REFERENCES

Let's Measure Metric. A Teacher's Introduction to Metric Measurement. Division of Educational Redesign and Renewal, Ohio Department of Education, 65 S. Front Street, Columbus, OH 43215, 1975, 80 pages; $1.50, must include check to state treasurer.

Activity-oriented introduction to the metric system designed for independent or group inservice education study. Introductory information about metric measurement; reproducible exercises apply metric concepts to common measurement situations; laboratory activities for individuals or groups. Templates for making metre tape, litre box, square centimetre grid.

Measuring with Meters, or, How to Weigh a Gold Brick with a Meter-Stick. Metrication Institute of America, P.O. Box 236, Northfield, IL 60093, 1974, 23 min., 16 mm, sound, color; $310.00 purchase, $31.00 rental.

Film presents units for length, area, volume and mass, relating each unit to many common objects. Screen overprints show correct use of metric symbols and ease of metric calculations. Relationships among metric measures of length, area, volume, and mass are illustrated in interesting and unforgettable ways.

Metric Editorial Guide. American National Metric Council, Washington, DC, 1975, 12 pages, $1.50 each, quantity prices available.

Set of recommendations serving as interim guide "to accepted metric practices." Section on rules for writing metric quantities covers: capitals, plurals, decimal points, grouping of numbers, spacing and compound units. Additional sections cover: common metric units and symbols, pronounciation, typewriting recommendations, longhand and shorthand recommendations and SI unit prefixes.

Metric Education, An Annotated Bibliography for Vocational, Technical and Adult Education. Product Utilization, The Center for Vocational Education, The Ohio State University, Columbus, OH 43210, 1974, 149 pages; $10.00.

Comprehensive bibliography of instructional materials, reference materials and resource list for secondary, post-secondary, teacher education, and adult basic education. Instructional materials indexed by 15 occupational clusters, types of materials, and educational level.

Metric Education, A Position Paper for Vocational, Technical and Adult Education. Product Utilization, The Center for Vocational Education, The Ohio State University, Columbus, OH 43210, 1975, 46 pages; $3.00.

Paper for teachers, curriculum developers, and administrators in vocational, technical and adult education. Covers issues in metric education, the metric system, the impact of metrication on vocational and technical education, implications of metric instruction for adult basic education, and curriculum and instructional strategies.

The Metric System and Its Impact on Business Education. Delta Pi Epsilon, Beta Mu Chapter, Central State College, New Britain, Connecticut, 1976, 51 pages.

Service project report giving information on history of metric system, its impact on business, industry, and education. Specific suggestions and materials for teaching metric in business math, consumer education, typewriting, and shorthand. Bibliography and supplementary sources listed: abstracts, books, conference reports, kits, pamphlets, and periodicals.

SI Metric: Style Manual for the International System of Units. International Business Machines Corporation, White Plains, NY, date unknown, 7 pages, $.50, order No. SR23-3723-0.

Guideline for IBM personnel illustrating use of SI units in written materials. Content covers punctuation, spelling, usage and format, SI base units, supplementary units, derived units with special names, prefixes of SI units, and derived units without special names.

The International System of Units (SI). The National Bureau of Standards, Washington, DC, 1974 ed., 43 pages, $.65, order by SD Catalog No. C13.10:330/3.

Commonly known as "NBS 330," booklet defines modernized metric system (SI). Contains resolutions and recommendations of General Conference on Weights and Measures, as well as International Organization for Standardization (ISO) on practical use of the system.

METRIC SUPPLIERS

Dick Blick Company, P.O. Box 1267, Galesburg, IL 61401

Instructional quality rules, tapes, metre sticks, cubes, height measures, trundle wheels, measuring cups and spoons, personal scales, gram/kilogram scales, feeler and depth gages, beakers, thermometers, kits and other aids.

INFORMATION SOURCES

American National Metric Council, 1625 Massachusetts Avenue, N.W., Washington, D C 20036

Charts, posters, reports and pamphlets, *Metric Reporter* newsletter. National metric coordinating council representing industry, government, education, professional and trade organizations.

National Bureau of Standards, Office of Information Activities, U.S. Department of Commerce, Washington, D C 20234.

Free and inexpensive metric charts and publications, also lends films and displays.