DOCUMENT RESUME

ED 134 768	08	CE 009 772

AUTHOR   Ccoper, Gloria S., Ed.; Magisos, Joel H., Ed.
TITLE   Metrics for Industrial Electronics, Radio-TV Repair,
              Audio Equipment Repair.
INSTITUTICN   Ohio State Univ., Columbus. Center for Vocational
              Education.
SPONS AGENCY Bureau of Occupational and Adult Education (DHEW/OE),
              Washington, D.C.
PUB DATE   76
CCNTRACT   OEC-0-74-9335
NOTE   ö5p.; For a related document see CE 009 736-790

EDRS PRICE   MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS   *Audio Equipment; *Curriculum; *Electronics;
              Instructional Materials; Learning Activities;
              Measurement Instruments; *Metric System; *Radio
              Technology; Secondary Education; Teaching Techniques;
              *Television Repairmen; *Trade and Industrial
              Education; Units of Study (Subject Fields);
              Vocaticnal Education

ABSTRACT
              Designed to meet the job-related metric measurement
needs of students in industrial electronics, radio-tv repair, and
audio equipment repair, this instructional package is one of eight
for the manufacturing occupations cluster, part of a set of 55
packages for metric instruction in different occupations. The package
is intended for students who already know the occupational
terminology, measuremen. terms, and tools currently in use. Each of
the five units in this instructional package 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 the 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. The material is designed to
accommodate a variety of individual teaching and learning styles,
e.g., independent study, small group, or whole-class activity.
Exercises are intended to facilitate experiences with measurement
instruments, tools, and devices used in this occupaticn and
job-related tasks of estimating and measuring. Unit I, a general
introduction to the metric system of measurement, 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 c   b-related metric equivalents and their relationships.
Unit 4 pr   es experience with recognizing and using metric
instruments and tools in cccupational measurement tasks. It also
provides experience in comparing metric and customary measurement
instruments. Unit 5 is designed to give students practice in
converting customary and metric measurements, a skill considered
useful during the transition to metric in each occupation. (HD)

metrics for metrics for
for metrics for metrics
metrics for metrics for
for metrics for metrics
metrics for metrics for
for metrics for metrics

metrics for industrial electronics, radio-tv repair, audio equipment repair

for metrics for metrics

metrics for metrics for

THE CENTER FOR VOCATIONAL EDUCATION

3

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 tea hing 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 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 with recognizing and using metric instruments and tools in occupational measurement tasks. It also provides experience in comparing metric and customary measurement instruments.

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 als 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.

Gloria S Cooper
Joël H. Magisos
Editors

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:	millimetre (mm)	square centimetre (cm^2)	cubic centimetre (cm^3)	gram (g)	degree Celsius $(^\circ C)$
2. Select, use, and read the appropriate measuring instruments for:	centimetre (cm) metre (m)	square metre (m^2)	cubic metre (m^3)	kilogram (kg)	
3. State or show a physical reference for:			litre (l) millilitre (ml)		
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.

Information Sheet 1

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'a)	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.
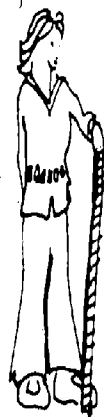
THAT IS HOW HIGH A METRE IS!

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.
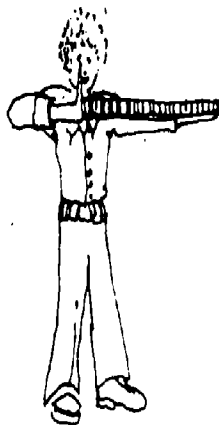
THAT IS HOW LONG A METRE IS!

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.
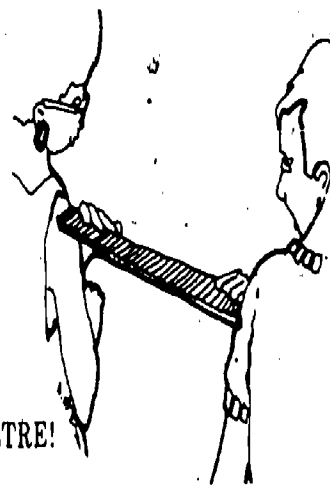
THAT IS THE WIDTH OF A METRE!

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

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. _____ m

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 m^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!

THE CENTER FOR VOCATIONAL EDUCATION

ERIC

14

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.

CENTIMETRE GRID

	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.	———	———	———
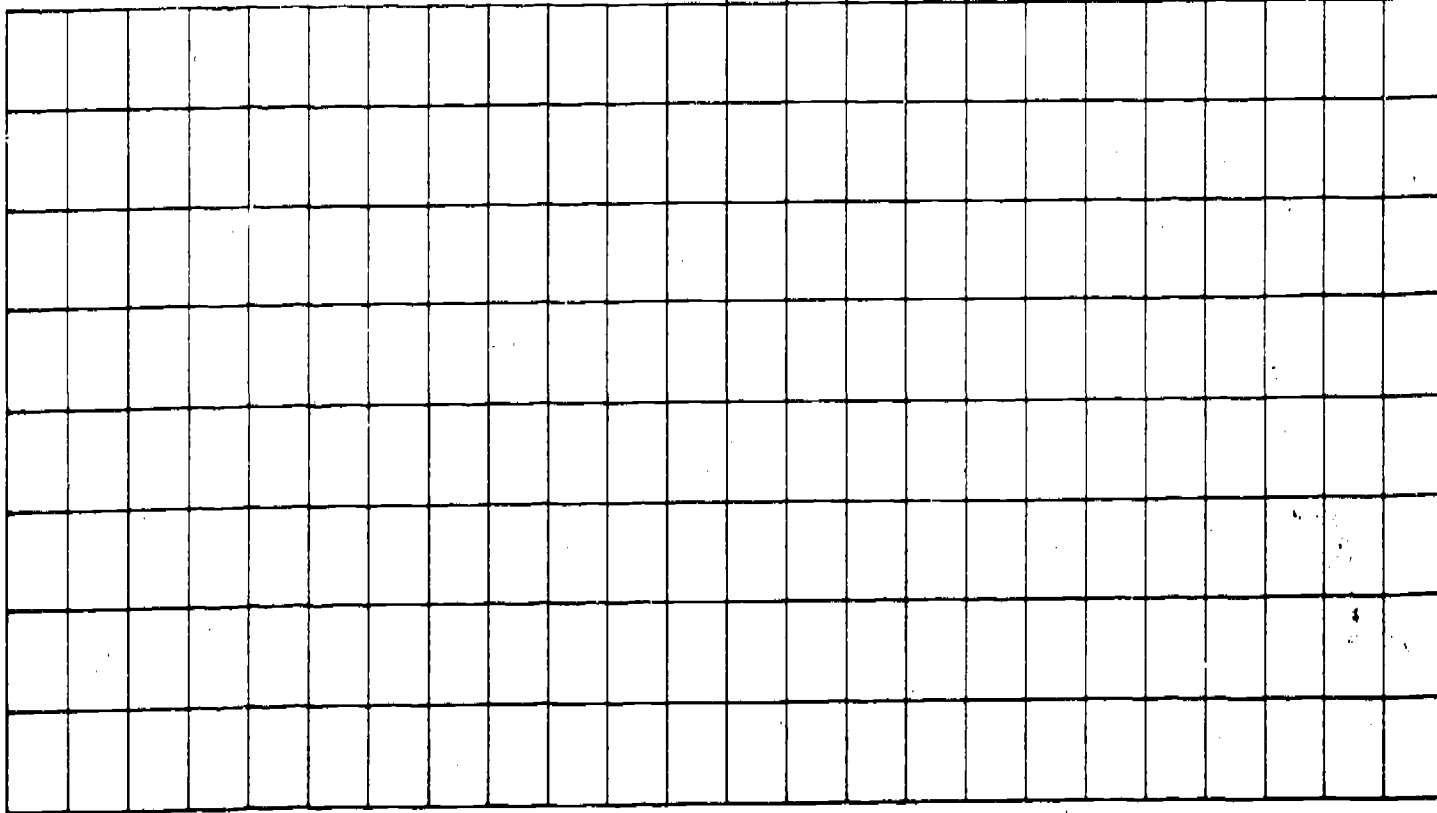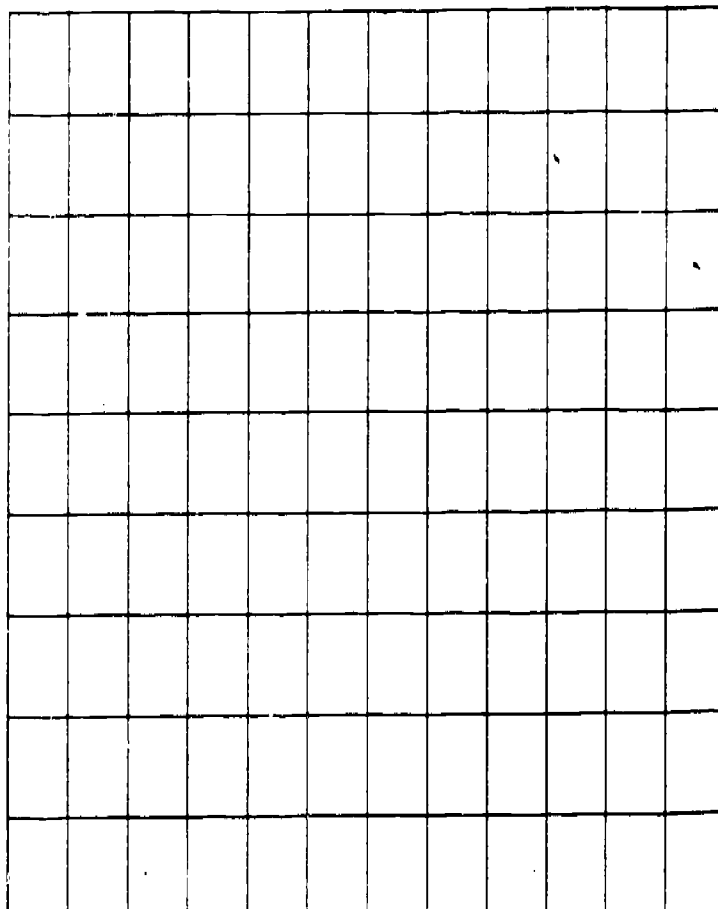
Exercise 2

VOLUME MEASUREMENT ACTIVITIES

Cubic Centimetre, Litre, Millilitre, Cubic Metre

I. THE CUBIC CENTIMETRE (cm³)

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 = _____cm³.
   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 (cm³)	Measurement (cm³)	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!

Exercise 3

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.			
ι. 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 proced-
ures 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.	_____	_____	_____

Exercise 4

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.			

THE CENTER FOR VOCATIONAL EDUCATION

Exercise 4

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.			

Exercise 5

THE CENTER FOR VOCATIONAL EDUCATION

UNIT 2

OBJECTIVES

The student will recognize and use the metric terms, units, and symbols used in this occupation.

- Given a metric unit, state its use in this occupation.

- Given a measurement task in this occupation, select the appropriate metric unit and measurement tool.

SUGGESTED TEACHING SEQUENCE

1. Assemble metric measurement tools (rules, tapes, scales, thermometers, etc.) and objects related to this occupation.

2. Discuss with students how to read the tools.

3. Present and have students discuss Information Sheet 2 and Table 2.

4. Have students learn occupationally-related metric measurements by completing Exercises 6 and 7.

5. Test performance by using Section A of "Testing Metric Abilities."

METRICS IN THIS OCCUPATION

Changeover to the metric system is under way. Large corporations are already using metric measurement to compete in the world market. The metric system has been used in various parts of industrial and scientific communities for years. Legislation, passed in 1975, authorizes an orderly transition to use of the metric system. As businesses and industries make this metric changeover, employees will need to use metric measurement in job-related tasks.

Table 2 lists those metric terms which are most commonly used in this occupation. These terms are replacing the measurement units used currently. What kinds of job-related tasks use measurement? Think of the many different kinds of measurements you now make and use Table 2 to discuss the metric terms which replace them. See if you can add to the list of uses beside each metric term.
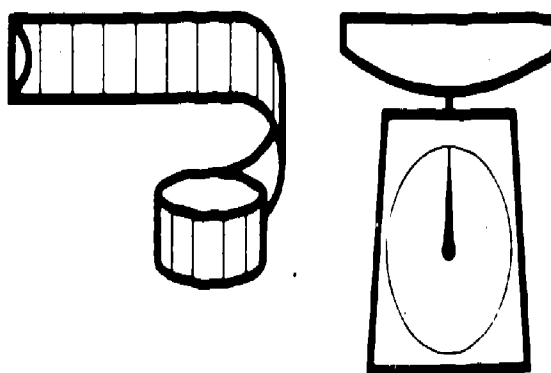
METRIC UNITS FOR INDUSTRIAL ELECTRONICS, RADIO-TV, AUDIO EQUIPMENT REPAIR

Quantity	Unit	Symbol	Use
Length	millimetre	mm	Length and diameter of fasteners; screws; bolts, wrench sizes; taps and dies; resistors and capacitors
	centimetre	cm	Length of control shafts; wire lengths; switch openings
	metre	m	Wiring runs; antenna length
	kilometre	km	Distance to suppliers and customers
Area	square millimetre	mm²	Capacitor plate
	square centimetre	cm²	Speaker baffle size; chassis layout; P/C boards
	square metre	m²	Space for installing audio control consoles; area to be serviced
Volume/Capacity	cubic centimetre	cm³	Installing audio consoles, control panels, speakers in room spaces; control box sizes
	cubic metre	m³	
	millilitre	ml	Purchasing chemicals
	litre	l	
Mass	gram	g	Stylus "pressure"* on a phonograph record; roll solder
	kilogram	kg	Roll solder
**Temperature	degree Celsius	°C	Effect of heat on components; melting point of solder; equipment specifications; equipment operating temperatures; calibrating and testing heat sensors
Pressure	kilopascal	kPa	Fluid pressure—air, water, gas lines
Power or heat flow rate	watt	W	Energy dissipation; lamp size
	kilowatt	kW	

*Newtons is the correct metric term for the measure of force and there is the possibility that measures of stylus pressure may later be changed to newtons.

**Kelvin (K) may also be used in scientific and technical temperature specifications and reports. The temperature K is called "absolute zero." On the commonly used Celsius temperature scale, water freezes at about 0°C (273 K) and boils at about 100°C (373 K).

NOTE: Most units currently used in electronics (e.g., Hertz, volt, ohm, ampere, decibel) will remain the same in the metric system.

ELECTRONIC COMPONENTS

ACTUAL SIZE OF COMPONENTS

10 mm → | ← 4 mm
½ W RESISTOR

20 mm | 9 mm
MINIATURE CAPACITOR

10 mm → | ← 5 mm
TOP VIEW OF INTEGRATED CIRCUIT

8 mm
TRANSISTOR

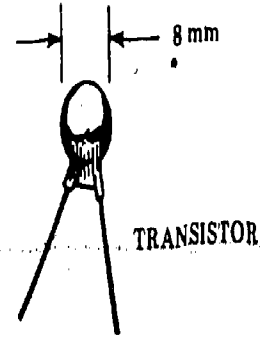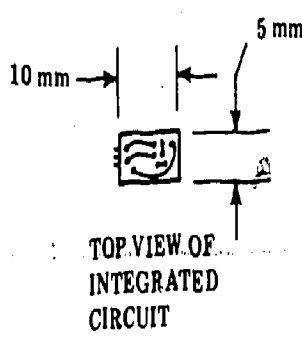THE CENTER FOR VOCATIONAL EDUCATION
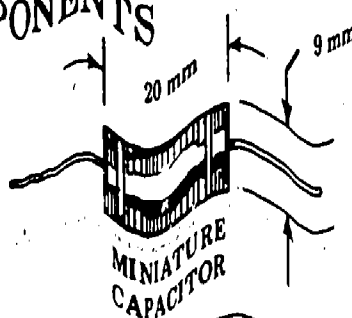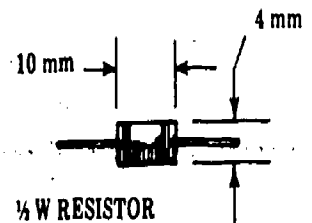
Table 2

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. Palm width		
2. Hand span		
3. Your height		
4. Resistor		
5. A.C. line cord		
6. Tone arm		
7. Soldering gun tip		
8. Scope probe		
9. Antenna		
Area		
10. Desk top		
11. Classroom floor		
12. Control console		
13. Printed circuit board		
14. Amplifier chassis		
Volume/Capacity		
15. Small bottle		

	Estimate	Actual
16. Measuring cup		
17. Milk container		
18. Motor grease cup		
19. Bucket		
20. Meter box		
21. Resistor cabinet		
22. Speaker cabinet		
Mass		
23. Textbook		
24. Tape cartridge		
25. Coil of solder		
26. Transformer		
27. Phono stylus		
28. Audio transformer		
Temperature		
29. Outside temperature		
30. Inside temperature		
31. Hot tap water		
32. Inside an amplifier cabinet		

Exercise 6

REPAIRING WITH METRICS

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

1. Height of modular tuner

2. Diameter of a tuner knob

3. Capacity of an eye dropper

4. Dimensions for a transistor heat sink:

    a. Length

    b. Width

5. Length of a ½-watt resistor

6. Height of power transformer when mounted on a chassis

7. Diameter of a light cell

8. Pressure in the air line

9. Closing distance of a relay

10. Dimensions of a printed circuit board:

    a. Length

    b. Width

11. Size of a drill bit (diameter)

12. Mass of a No. 6 self tapping screw

13. Width of a video tape

14. Height of tape recorder recording head

15. Capacity of a small bottle of control cleaner

16. Volume of the tool box

17. Length of a chassis screw

18. Width of integrated circuit

19. Diameter of a small speaker

20. Width of a tape recorder play-back head

21. Length of a standard antenna mast

22. Area of printed circuit board

23. Temperature of working amplifier

24. Dimensions of a capacitor:

    a. Length

    b. Diameter

25. Mass of a tube of lubriplate

26. Width of a cassette tape

27. Width of a reel audio tape

28. Volume of a speaker cabinet

29. Stylus "pressure"

30. Volume of cleaning solvent

Exercise 7

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 (8 - 14), 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
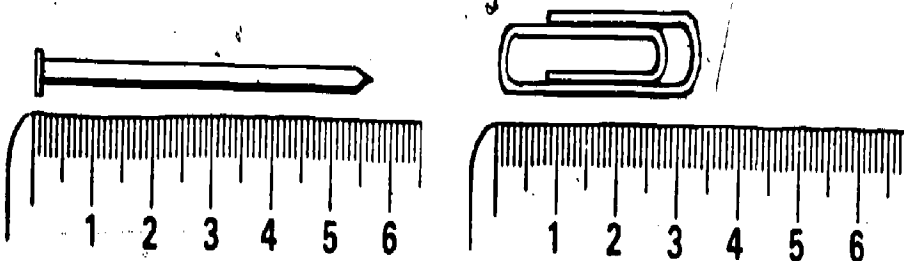
Look at the picture of the nail next to the ruler. The nail is 57 mm long. This is 5 cm + 7 mm. There are 10 mm in each cm, so 1 mm = 0.1 cm (one-tenth of a centimetre). This means that 7 mm = 0.7 cm, so 57 mm   = 5 cm + 7 mm

$$= 5 \text{ cm} + 0.7 \text{ cm}$$

$$= 5.7 \text{ cm}. \text{ Therefore } 57 \text{ mm is the same as } 5.7 \text{ cm}.$$

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

$$= 3 \text{ cm} + 0.4 \text{ cm}$$

$$= 3.4 \text{ cm}. \text{ This means that } 34 \text{ mm is the same as } 3.4 \text{ cm}.$$

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 8

THE CENTER FOR VOCATIONAL EDUCATION

Metres, Centimetres, and Millimetres

There are 100 centimetres in one metre. Thus,

$$2\,m = 2 \times 100\,cm = 200\,cm,$$
$$3\,m = 3 \times 100\,cm = 300\,cm,$$
$$8\,m = 8 \times 100\,cm = 800\,cm,$$
$$36\,m = 36 \times 100\,cm = 3\,600\,cm.$$

There are 1 000 millimetres in one metre, so

$$2\,m = 2 \times 1\,000\,mm = 2\,000\,mm,$$
$$3\,m = 3 \times 1\,000\,mm = 3\,000\,mm,$$
$$6\,m = 6 \times 1\,000\,mm = 6\,000\,mm,$$
$$24\,m = 24 \times 1\,000\,mm = 24\,000\,mm.$$

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

$$0.75\,m = 0.75 \times 1\,000\,mm$$
$$= \frac{75}{100} \times 1\,000\,mm$$
$$= 75 \times \frac{1\,000}{100}\,mm$$
$$= 75 \times 10\,mm$$
$$= 750\,mm.\ \text{This means that } 0.75\,m = 750\,mm.$$

Information Sheet 4

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 milli-litres to litres is to divide by 1 000. For example,

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

And, as a final example,

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

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

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

Change 57 millilitres to litres.

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

Information Sheet 5

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
		118
	639	

Exercise 9

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 10

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	
16	
	22 000
0.4	
0.53	
	480

Exercise 11

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 12

Kilograms to Grams

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

    1 kg = 1   x 1 000 g = 1 000 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	
9.63	
	175

Exercise 13

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 wire is _____ m

b) 1 250 ml of solution is _____ l

c) 5 cm diameter speaker is _____ mm

d) 2 500 g of solder is _____ kg

e) 120 mm wide chassis is _____ cm

f) 0.25 l of liquid cleaner is _____ ml

g) 60 kg TV set is _____ g

h) 0.5 l of concentrate is _____ ml

i) 2 m board is _____ mm

j) 500 g of transistors is _____ kg

k) 500 ml of spray paint is _____ l

l) 10 m of wire is _____ cm

m) 2.5 cm insulator is _____ mm

n) 2 400 mm length of cable is _____ cm

THE CENTER FOR VOCATIONAL EDUCATION

ERIC

Exercise 14

UNIT 4

OBJECTIVE

The student will recognize and use instruments, tools, and devices for measurement tasks in this occupation.

- Given metric and Customary tools, instruments, or devices, differentiate between metric and Customary.

- Given a measurement task, select and use an appropriate tool, instrument or device.

- Given a metric measurement task, judge the metric quantity within 20% and measure within 2% accuracy.

SUGGESTED TEACHING SEQUENCE

1. Assemble metric and Customary measuring tools and devices (rules, scales, ^{0}C thermometer, drill bits, wrenches, micrometer, vernier calipers, feeler gages) and display in separate groups at learning stations.

2. Have students examine metric tools and instruments for distinguishing characteristics and compare them with Customary tools and instruments.

3. Have students verbally describe characteristics.

4. Present or make available Information Sheet 9.

5. Mix metric and Customary tools or equipment at learning station. Give students appropriate Exercises 15 and 16.

6. Test performance by using Section C of "Testing Metric Abilities."

SELECTING AND USING METRIC INSTRUMENTS, TOOLS AND DEVICES

Selecting an improper tool or misreading a scale can result in an improper sales form, damaged materials, or injury to self or fellow workers. For example, putting 207 pounds per square inch of pressure (psi) in a truck tire designed for 207 kilopascals (about 30 psi) could cause a fatal accident. Here are some suggestions:

1. Find out in advance whether Customary or metric units, tools, instruments, or products are needed for a given task.

2. Examine the tool or instrument before using it.

3. The metric system is a decimal system. Look for units marked off in whole numbers, tens or tenths, hundreds or hundredths.

4. Look for metric symbols on the tools or gages such as m, mm, kg, g, kPa, etc.

5. Look for decimal fractions (0.25) or decimal mixed fractions (2.50) rather than common fractions (3/8) on drill bits, feeler gages, etc.

6. Some products may have a special metric symbol such as a block M to show they are metric.

7. Don't force bolts, wrenches, or other devices which are not fitting properly.

8. Practice selecting and using tools, instruments, and devices.
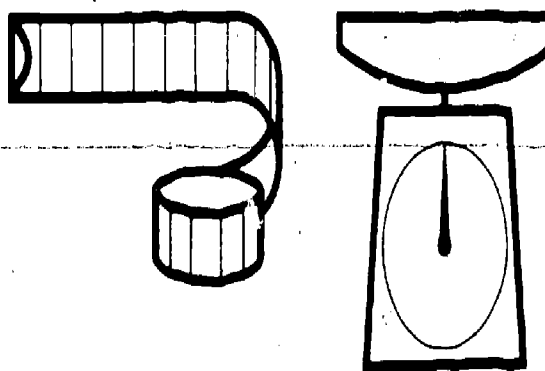
43

Information Sheet 9

WHICH TOOLS FOR THE JOB?

Practice and prepare to demonstrate your ability to identify, select, and use metric-scaled tools and instruments for the tasks given below. You should be able to use the measurement tools to the appropriate precision of the tool, instrument, or task.

Select and demonstrate or describe use of tools, instruments, or devices to:

1. Drill a hole in a metal chassis to fit a rubber grommet.

2. Measure the wire needed to go from the control panel to the operating equipment.

3. Read the temperature in an electric oven.

4. Measure the pressure needed to activate a pressure switch.

5. Find the mass of a piece of equipment which will be hung on a wall.

6. Measure the diameter of the screw used to fasten a switch into the switch box.

7. Measure the overall diameter of the wire used for 220 V installations.

8. Measure the contact opening on a power relay.

9. Determine the area needed by the console control.

10. Determine the area of a circuit panel.

11. Measure the diameter of a control shaft.

12. Measure for cutting a piece of perforated phenolic for a 14 cm x 10 cm printed circuit board.

MEASURING UP IN INDUSTRIAL ELECTRONICS

For the tasks below, estimate the metric measurement to within 25% of actual measurement, and verify the estimation by measuring to within 5% of actual measurement.

	Estimate	Verify
1. Space needed to install master intercom unit in a wall:		
a. Width		
b. Length		
c. Depth		
2. Depth of a panel meter.		
3. The thickness of a printed circuit board.		
4. The amount of video tape left on a half used reel.		
5. The length of a screw used to fasten a printed circuit board to a chassis.		
6. Length of cable needed for the video camera.		
7. Mass of a TV camera to be mounted.		
8. Volume of tube.		
9. Dimensions of a plate transformer.		
10. The mass of a small roll of solder.		
11. Measure the diameter of the soldering iron.		
12. Diameter of the shaft of a replacement gang switch.		

WHICH TOOLS FOR THE JOB?

Practice and prepare to demonstrate your ability to *identify, select, and use* metric-scaled tools and instruments for the tasks given below. You should be able to use the measurement tools to the appropriate precision of the tool, instrument, or task.

Select and demonstrate or describe use of tools, instruments, or devices to:

1. Bore a 10 mm hole in a speaker cabinet to mount an "L" pad.

2. Measure the lead-in wire needed to mount an antenna near your laboratory.

3. Heat a circuit board to a specified temperature with the use of a heat lamp.

4. Measure the stylus "pressure" on a phonograph record.

5. Measure the extended length of an F.M. portable radio antenna.

6. Measure the length and diameter of the screws needed to put the back on a TV.

7. Measure the diameter of a tuner shaft.

8. Select the screws needed to mount a perforated circuit board.

9. Calculate the floor area needed for a large color TV console.

10. Cut a piece of perforated phenolic for a 14 cm x 10 cm printed circuit board.

MEASURING UP IN RADIO-TV

For the tasks below, estimate the metric measurement to within 20% of actual measurement, and verify the estimation by measuring to within 2% of actual measurement.

	Estimate	Verify
1. Workbench area for TV chassis		
2. Diameter of the color tube base connector		
3. Mount earphone jack on cabinet; drill hole needed		
4. Diameter of the tuner shaft		
5. Replacing a loudspeaker		
6. Length of a phono tone arm		
7. Mass of the phono cartridge		
8. Dimensions of the loudspeaker in a radio or TV:		
a. Width		
b. Length		
9. The thickness of a TV printed circuit board		
10. The diameter of the volume control in a small radio		
11. Replace a chassis mounted capacitor		
12. Measure the channel selector shaft length		

WHICH TOOLS FOR THE JOB?

Practice and prepare to demonstrate your ability to *identify, select, and use* metric-scaled tools and instruments for the tasks given below. You should be able to use the measurement tools to the appropriate precision of the tool, instrument, or task.

Select and demonstrate or describe use of tools, instruments, or devices to:

1. Bore a hole in a speaker cabinet to mount an "L" pad.

2. Measure the wire needed to run from an audio amp to a wall speaker.

3. Measure the size opening needed to install a microphone wall jack.

4. Heat a circuit board to a specified temperature with the use of a heat lamp.

5. Measure the stylus pressure on a record.

6. Measure the length and diameter of the screws used to fasten the back on an amplifier.

7. Select the drill bit to drill the hole for a No. 6 self-tapping screw.

8. Measure the maximum extended height of a microphone stand.

9. Determine the area needed for an audio control console.

10. Measure the dimensions of a replacement speaker baffle.

11. Measure the distance between holes for mounting a line matching transformer.

12. Measure the thickness of a stack of ten records.

13. Measure the tip temperature of a 25 watt soldering iron.

MEASURING UP IN AUDIO EQUIPMENT REPAIR

For the tasks below, estimate the metric measurement to within 20% of actual measurement, and verify the estimation by measuring to within 2% of actual measurement.

	Estimate	Verify
1. Area of a tape deck		
2. Depth of a 12-inch speaker		
3. Amount of control cleaner in a bottle		
4. The size opening needed to mount a turntable		
5. Mass of a cassette tape		
6. Length of a phono tone arm		
7. Dimensions of the phono cartridge		
8. Dimensions of a loudspeaker baffle: a. Width		
b. Length		
c. Thickness		
9. The thickness of a printed circuit board		
10. The thickness of the volume control		
11. The length of the tone control shaft		
12. The mass of a small package of solder		

Exercise 15

(Audio Equipment)

Exercise 16

(Audio Equipment)

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 and Table 3.

3. Have students find approximate metric-Customary equivalents by using Exercise 17.

4. Test performance by using Section D of "Testing Metric Abilities."

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.

Table 3 on the next page gives an example of a metric-Customary conversion table which you can use for practice in finding approximate equivalents. Table 3 can be used with Exercise 17, Part 2 and Part 3.

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 17, Part 1 and Part 3. 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 cm² ≈ 0.16 sq in	1 sq in ≈ 6.5 cm²	1 l ≈ 2.1 pts	1 pt ≈ 0.47 l
1 m² ≈ 10.8 sq ft	1 sq ft ≈ 0.09 m²	1 l ≈ 1.06 qt	1 qt ≈ 0.
1 m² ≈ 1.2 sq yd	1 sq yd ≈ 0.8 m²	1 l ≈ 0.26 gal	1 gal ≈ 3.
1 hectare ≈ 2.5 acres	1 acre ≈ 0.4 hectare	1 gram ≈ 0.035 oz	1 oz ≈ 28.3 g
1 cm³ ≈ 0.06 cu in	1 cu in ≈ 16.4 cm³	1 kg ≈ 2.2 lb	1 lb ≈ 0.45 kg
1 m³ ≈ 35.3 cu ft	1 cu ft ≈ 0.03 m³	1 metric ton ≈ 2205 lb	1 ton ≈ 907.2 kg
1 m³ ≈ 1.3 cu yd	1 cu yd ≈ 0.8 m³	1 kPa ≈ 0.145 psi	1 psi ≈ 6.895 kPa

THE CENTER FOR VOCATIONAL EDUCATION

Information Sheet 10

CONVERSION TABLES

MILLIMETRES TO INCHES

mm	Inches	mm.	Inches	mm	Inches	mm	Inches
100	3.93	10	0.39	1	0.04	0.1	0.004
200	7.87	20	0.79	2	0.08	0.2	0.008
300	11.81	30	1.18	3	0.12	0.3	0.012
400	15.74	40	1.57	4	0.16	0.4	0.016
500	19.68	50	1.97	5	0.20	0.5	0.020
600	23.62	60	2.36	6	0.24	0.6	0.024
700	27.56	70	2.76	7	0.28	0.7	0.028
800	31.50	80	3.15	8	0.31	0.8	0.031
900	35.43	90	3.54	9	0.35	0.9	0.035

1 000 mm or 1 metre = 39.37 inches

INCHES TO MILLIMETRES

Inches	mm	Inches	mm	Inches	mm	Inches	mm
1	25.4	0.1	2.54	.01	0.254	.001	0.025
2	50.8	0.2	5.08	.02	0.508	.002	0.050
3	76.2	0.3	7.62	.03	0.762	.003	0.076
4	101.6	0.4	10.16	.04	1.02	.004	0.102
5	127.0	0.5	12.70	.05	1.27	.005	0.127
6	152.4	0.6	15.24	.06	1.52	.006	0.152
7	177.8	0.7	17.78	.07	1.78	.007	0.178
8	203.2	0.8	20.32	.08	2.03	.008	0.203
9	228.6	0.9	22.86	.09	2.29	.009	0.229

10 inches = 254 mm

12 inches or 1 feet = 304.8 mm or 30.48 cm

THE CENTER FOR VOCATIONAL EDUCATION

Table 3

1. With the change to metric measurement some of the things you order, sell or use are marked only in metric units. You will need to be familiar with appropriate Customary equivalents in order to communicate with customers and suppliers who use Customary units. To develop your skill use the Table on Information Sheet 10 and give the approximate metric quantity (both number and unit) for each of the following Customary quantities.

Customary Quantity	Metric Quantity
a) 2 lbs. of assorted resistors	
b) 1 pt. of control cleaner	
c) 50 ft. of speaker cable	
d) 5 lb. roll of solder	
e) 24 sq. ft. work area	
f) 18 in. control panel	
g) two-gallon can	
h) 1 qt. of chemical	
i) 6 fl. oz. of control cleaner	
j) 3 miles	
k) 1/2 in. chassis hole	
l) 2 ft. piece of wire	
m) 6 in. speaker	
n) 1/4 in. thick cabinet board	

2. Use the conversion tables from Table 3 to convert the following:

a) 25 mm = _____ in.
b) 2 in. = _____ mm
c) 300 mm = _____ in.
d) 5 1/2 in. = _____ mm
e) 0.05 in. = _____ mm
f) 0.005 in. = _____ mm
g) 600 mm = _____ in.
h) 50 mm = _____ in.
i) 0.5 mm = _____ in.
j) 250 mm = _____ in.

3. Complete the Requisition Form using the items listed. Convert the Customary quantities to metric before filling out the form. Complete all the information (Date, For, Job No., etc.). Requisition one of each of the following items:

a) 1 pt. of solvent
b) one 6 fl. oz. spray can of control cleaner
c) 100 ft. of speaker wire
d) 2 lbs. of solder
e) two 8 in. speakers
f) one roll of 3/4 in. electric tape

REQUISITION

Date _____

For _____

Job No. _____ Date Wanted _____

Deliver to _____

QTY	UNIT	ITEM

Requested by _____

Approved by _____

54   55

THE CENTER FOR VOCATIONAL EDUCATION

Exercise 17

26

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. The pressure at a pressure indicator would be read in:

   [A] kilopascals

   [B] kilograms

   [C] metres

   [D] litres

4. The dimensions of a resistor would be in:

   [A] millilitres

   [B] millimetres

   [C] metres

   [D] centimetres

5. Roll solder is purchased by:

   [A] litres, millilitres

   [B] cubic metres, cubic centimetres

   [C] grams, kilograms

   [D] metres, centimetres

6. A small bottle of control cleaner would be measured in:

   [A] litres

   [B] grams

   [C] millilitres

   [D] kilograms

7. The correct way to write twelve thousand millimetres is:

   [A] 12,000 mm.

   [B] 12.000 mm

   [C] 12 000mm

   [D] 12 000 mm

8. The correct way to write twenty grams is:

   |A| 20 gms

   [B] 20 Gm.

   [C] 20 g.

   [D] 20 g
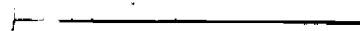
SECTION B

9. A 250 millilitre container of cleaner is the same as:

   [A] 250 litres

   [B] 2.5 litres

   [C] 0.25 litre

   [D] 0.025 litre

10. A circuit board 5 centimetres wide also has a width of:

    [A] 500 millimetres

    [B] 5 millimetres

    [C] 50 millimetres

    [D] 0.5 millimetre

11. A box of mounting hardware with a mass of 4 kilograms also has a mass of:

    [A] 400 000 grams

    [B] 40 000 grams

    [C] 4 000 grams

    [D] 400 grams

12. Estimate the length of the line segment below:

    [A] 23 grams

    [B] 6 centimetres

    [C] 40 millimetres

    [D] 14 pascals

13. Estimate the length of the line segment below:

    [A] 10 millimetres

    [B] 4 centimetres

    [C] 4 pascals

    [D] 23 milligrams

SECTION C

14. For measuring grams you would use a:

    [A] tape

    [B] ruler

    [C] pressure gage

    [D] scale

15. For measuring kilopascals you would use a:

    [A] ruler

    [B] scale

    [C] pressure gage

    [D] container

TESTING METRIC ABILITIES

57

16. For measuring in millimetres you
would use a:

[A] scale

[B] pressure gage

[C] container

[D] ruler

SECTION D

17. The metric unit for mass which
replaces the dry ounce is:

[A] millimetre

[B] litre

[C] gram

[D] metre

18. The metric unit for liquid measure
which replaces the fluid ounce is:

[A] hectare

[B] gram ●

[C] litre

[D] millilitre

19. The metric unit for mass which
replaces the pound is:

[A] kilogram

[B] millimetre

[C] milligram

[D] kilometre

Use this conversion table to
answer questions 20 and 21.

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

20. The equivalent of 910 mm is:

[A] 18.75 in.

[B] 35.82 in.

[C] 91.00 in.

[D] 35.43 in.

21. The equivalent of 210 mm is:

[A] 8.0 in.

[B] 8.26 in.

[C] 20.0 in.

[D] 20.26 in.

TESTING METRIC ABILITIES

THE CENTER FOR VOCATIONAL EDUCATION

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 2. Standards in each occupation are being established now, so answers may vary.

EXERCISE 8

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

EXERCISES 9 THRU 13

Tables are reproduced in total. Answers are in parentheses.

Exercise 9

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 10

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 11

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 12

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

Exercise 13

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

Exercise 14

a)	5 m	h)	500 ml
b)	1.25 litres	i)	2 000 mm
c)	50 mm	j)	0.5 kg
d)	2.5 kg	k)	0.5 litre
e)	12 cm	l)	1 000 cm
f)	250 ml	m)	25 mm
g)	60 000 g	n)	240 cm

EXERCISES 15 AND 16

The answers depend on the items used for the activities.

EXERCISE 17

Part 1.

a)	0.90 kg	h)	0.95 litre
b)	0.47 litre	i)	177.6 ml
c)	15.25 m	j)	4.83 km
d)	2.25 kg	k)	1.27 cm
e)	2.16 m^2	l)	0.61 m
f)	45.72 cm	m)	15.24 cm
g)	7.58 litres	n)	0.635 cm

Part 2.

a)	0.99 in.
b)	50.8 mm
c)	11.81 in.
d)	139.70 mm
e)	1.27 mm
f)	0.127 mm
g)	23.62 in.
h)	1.97 in.
i)	0.020 in.
j)	9.84 in.

Part 3.

a)	0.47 litre
b)	177.6 ml
c)	30.5 m
d)	0.9 kg
e)	2 - 20.32 cm
f)	1.905 cm

TESTING METRIC ABILITIES

1.	C	8.	D	15.	C
2.	B	9.	C	16.	D
3.	A	10.	C	17.	C
4.	B	11.	C	18.	D
5.	C	12.	B	19.	A
6.	C	13.	A	20.	B
7.	D	14.	D	21.	B

THE CENTER FOR VOCATIONAL EDUCATION

60

61

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

THE CENTER FOR VOCATIONAL EDUCATION

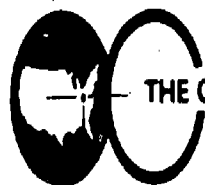The Ohio State University · 1960 Kenny Road · Columbus Ohio 43210

SUGGESTED METRIC TOOLS AND DEVICES
NEEDED TO COMPLETE OCCUPATIONAL
MEASUREMENT TASKS

In this occupation the tools needed to complete Exercises 6, 15, and 16 are indicated by "★."

★ A. Assorted Metric Hardware—Hex nuts, washers, screws, cotter pins, etc.

★ B. Drill Bits—Individual bits or sets, 1 mm to 13 mm range

★ C. Vernier Caliper—Pocket slide type, 120 mm range

★ D. Micrometer—Outside micrometer caliper, 0 mm to 25 mm range

E. Feeler Gage—13 blades, 0.05 mm to 1 mm range

F. Metre Tape—50 or 100 m tape

G. Thermometers—Special purpose types such as a clinical thermometer

★ H. [1] Temperature Devices—Indicators used for ovens, freezing/cooling systems, etc.

★ I. Tools—Metric open end or box wrench sets, socket sets, hex key sets

J. Weather Devices—Rain gage, barometer, humidity, wind velocity indicators

K. [1] Pressure Gages—Tire pressure, air, oxygen, hydraulic, fuel, etc.

L. [1] Velocity—Direct reading or vane type meter

M. Road Map—State and city road maps

N. Containers—Buckets, plastic containers, etc., for mixing and storing liquids

O. Containers—Boxes, buckets, cans, etc., for mixing and storing dry ingredients

Most of the above items may be obtained from local industrial, hardware, and school suppliers. Also, check with your school district's math and science departments and/or local industries for loan of their metric measurement devices.

[1] Measuring devices currently are not available. Substitute devices (i.e., thermometer) may be used to complete the measurement task.

Tools and Devices List

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 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.

Metrics in Career Education. Lindbeck, John R., Charles A. Bennett Company, Inc., 809 W. Detweiller Drive, Peoria, IL 61614, 1975, 103 pages, $3.60, paper; $2.70 quantity school purchase.

Presents metric units and notation in a well-illustrated manner. Individual chapters on metrics in drafting, metalworking, woodworking, power and energy, graphic arts, and home economics. Chapters followed by several learning activities for student use. Appendix includes conversion tables and charts.

Taking the Tricks Out of Metrics. Metric Training Department, Creative Universal, Inc., Tower 14, 21700 Northwestern Highway, Southfield, MI 48975, 1976, 4 booklets; $3.00 each, $12.00 set, discounts.

Series of booklets presents step-by-step directions, questions, answers on how to read metric measurement tools: micrometers, vernier calipers, rules, dial indicators.

METRIC SUPPLIERS

Brown & Sharpe Manufacturing Co., Precision Park, North Kingstown, RI 02852

Industrial quality micrometers, steel rules, screw pitch and thickness gages, squares, depth gages, calipers, dial indicators, conversion charts and guides.

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.

General Cement Corporation, Rockford, IL 61101

Metric electronic hardware and tools.

The L. S. Starrett Company, 121 Crescent Street, Athol, MA 01331

Machine tool precision measuring devices, micrometers, calipers, dial indicators, steel rules.

Millimeter Industrial Supply Corp., 162 Central Avenue, Farmingdale, L. I., NY 11735

Industrial fasteners, taps, dies, reamers, drills, wrenches, rings, bushings, calipers, steel rules and tapes, feeler gages.

Ohaus Scale Corporation, 29 Hanover Road, Florham Park, NJ 07932

Instructional quality and precision balances and scales, plastic calipers and stackable gram cubes for beginners.

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.

Metric Study Committee, Electronic Industries Association, 2001 Eye Street, N.W., Washington, D C 20006

Trade association. Publications concerning product standards and metric changeover in electronics manufacturing.

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.