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THE CENTER FOR VOCATIONAL EDUCATION

metrics for metrics for

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 keypunching input data using metric units, terms and symbols.

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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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.

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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

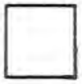
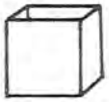
Quantity	Metric Unit	Symbol	Useful Referents
Length	millimetre	mm	Thickness of dime or paper clip wire
	centimetre	cm	Width of paper clip
	metre	m	Height of door about 2 m
	kilometre	km	12-minute walking distance
Area	square centimetre	cm^2	Area of this space 
	square metre	m^2	Area of card table top
	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

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Table 1–a

METRIC PREFIXES

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

Table 1–b

LINEAR MEASUREMENT ACTIVITIES

Metre, Centimetre, Millimetre

I. THE METRE (m)

A. DEVELOP A FEELING FOR THE SIZE OF A METRE

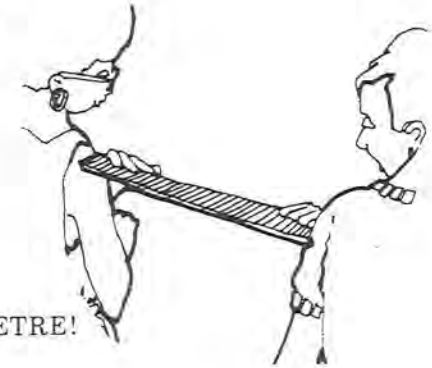
1. Pick up one of the metre sticks and stand it up on the floor. Hold it in place with one hand. Walk around the stick. Now stand next to the stick. With your other hand, touch yourself where the top of the metre stick comes on you.

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!

Exercise 2

(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 <u>quickly</u> 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 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.

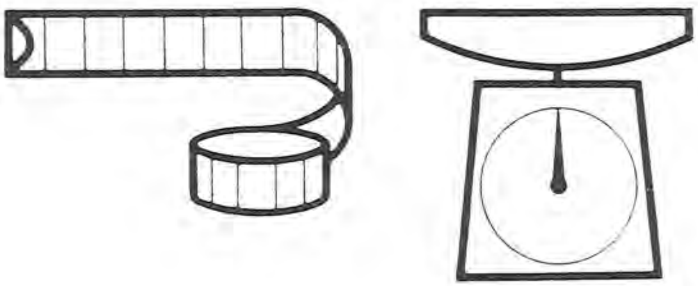
SUGGESTED TEACHING SEQUENCE

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. Review Table 1a and discuss how these measurements can be used in this occupation.
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 1a 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 1a to discuss the metric terms which replace them. See if you can add to the list of uses beside each metric term.



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. Width of a card file drawer		
3. Height of a chair seat		
4. Width of a key-punch ribbon		
5. Length of a standard tab card		
6. Length of a card file drawer		
7. Length of a card punch machine		
8. Height of a doorway		
9. Thickness of a stack of tab cards		
Area		
10. Desk top		
11. Classroom floor		
12. Work area		
13. Standard tab card		
14. Sheet of paper		
Volume/Capacity		
15. Desk drawer		

	Estimate	Actual
16. Water cooler		
17. Container of hand cleaner		
18. Coffee cup		
19. Wastebasket		
20. Small box or package		
21. Card file drawer		
22. Flower or plant container		
Mass		
23. Textbook		
24. Nickel		
25. Yourself		
26. Paper clip		
27. A stack of punched cards		
28. A litre of water (net)		
Temperature		
29. Room temperature		
30. Outside temperature		
31. Hot tap water		
32. Ice water		

KEY PUNCHING WITH METRICS

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

The dimensions of a punch card	
The area of a key punch machine	
The mass of a stack of punched cards	
The capacity of a bottle of rubber cement	
The capacity of a coffee maker	
Area of key punch work or read area	
The capacity of a wastebasket	
Diameter of a program drum	
Capacity of a machine's card hopper	
Length of the space bar	
Width of key punch ribbon	
Height of a filing cabinet	
Temperature of work area	
Mass of a ream of paper	
Height of chair seat	

2. For each item below, select the appropriate metric unit.

The length of a punch card:

a) metres
b) litres
c) grams
d) centimetres

The width of punched tape:

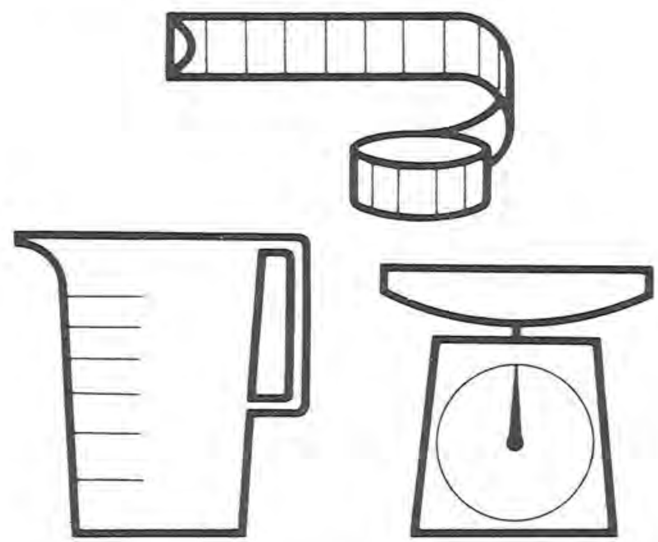
a) millimetres
b) grams
c) millilitres
d) cubic metres

The temperature of a computer equipment area:

a) kelvins
b) degrees Celsius
c) Fahrenheit
d) BTU

Mileage for picking up and dispatching programs:

a) metres
b) kilometres
c) millimetres
d) centimetres



UNIT 3

OBJECTIVE

The student will recognize and use metric equivalents.

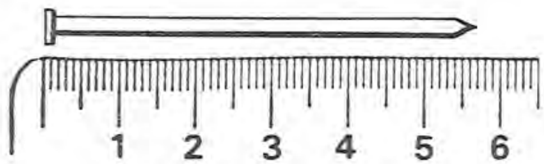
- Given a metric unit, state an equivalent in a larger or smaller metric unit.

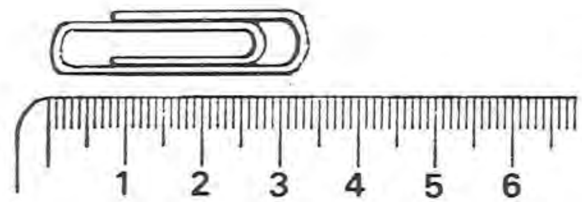
SUGGESTED TEACHING SEQUENCE

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

Exercise 8

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 9

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,

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

Or

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

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 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	
46	
	32 000
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.

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 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 cord is ______________ m
b) 250 ml of solution is ______________ l
c) 5 cm wide column is ______________ mm
d) 2 500 g of punched cards is ______________ kg
e) 120 mm wide cabinet is ______________ cm
f) 0.25 litre of liquid cleaner is ______________ ml
g) 2 000 kg computer is ______________ t
h) 0.5 litre of concentrate is ______________ ml
i) 2 m high door is ______________ mm
j) 500 g instruction manual is ______________ kg
k) 500 ml of water is ______________ l
l) 0.5 t of punched cards is ______________ kg
m) 10 m of twine is ______________ cm
n) 3.5 cm paper clip is ______________ mm
o) 2 400 mm room divider length is ______________ cm

Exercise 14

UNIT 4

OBJECTIVES

The student will key punch correctly and proof input data, and verify output, using special metric symbols for key punching.

- Given input data containing metric terms, correctly key punch the data using proper rules of notation.
- Given a metric quantity, write the measurement in special metric symbols for key punching.

SUGGESTED TEACHING SEQUENCE

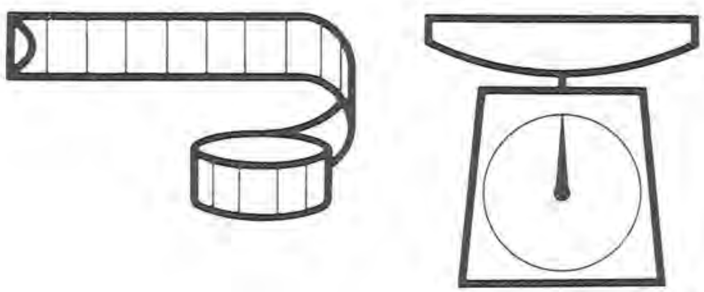
1. Present or make available Information Sheet 9 and Tables 1b, 2, and 3.
2. Discuss how to use these tables as reference guides.
3. Have students use the reference materials to key punch Exercise 15.
4. Have students use the reference materials to write out special metric key punch symbols in Exercise 16.

METRICS IN THE OFFICE

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, and key punch data.

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 say and spell the names of metric units, write the symbols, and use proper metric notation. In addition, they need to be able to spot when a term has been used inappropriately--for example, if kilolitre is used to describe distance instead of kilometre, or a person is billed for 500 kilograms of chocolate (half a metric ton) instead of 500 grams (about a pound).

Metric prefixes are located in Table 1b. Table 2 is a style reference containing key punch rules for punctuation, spacing, spelling, fractions and mathematical operations, as well as special metric symbols. Table 3 gives the correct spelling of metric units and symbols for key punching.



PROCESS IT METRIC STYLE!

One of the primary concerns of the data processor will be that of correctly identifying and key punching metric terms and symbols. The following rules should be followed:

RULE 1: KEY PUNCHING THE NUMBERS METRICALLY*

1.1 The comma will no longer be used to denote thousands; however a space will be left after each group of 3 numbers. The exception to this rule would be four digit numbers. They may be key punched with or without the space unless they occur in a tabulation, at which time they should align.

Correct:	56 987 1 932 871	Incorrect:	56,987 1932,871

1.2 When a decimal point is used to denote a fractional breakdown, do not key punch spaces before or after the decimal.

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

1.3 Fractions are not used in metric figures. Convert them to their decimal equivalent.

Correct:	0.75 1.20	Incorrect:	3/4 1 1/5

1.4 If a decimal point is not preceded by a number a zero should be added.

Correct:	0.16 0.8713	Incorrect:	.16 .8713

1.5 Superscripts are indicated by the numeral placed directly after the symbol. Negative exponents are indicated by placing the minus sign and numeral directly after the symbol.

Correct:	M2 S-1	Incorrect	M 2 S - 1

RULE 2: USING THE METRIC SYMBOLS AND UNIT NAMES*

2.1 Nearly all key punch machines manufactured in the United States have the capability to punch and print letters only in the upper case. Table 3 on page 20 lists the proper form to use when key punching metric symbols. (Also see important note at the end of this table.)

2.2 A space is left between the number and the symbol. Since the metric symbols are internationally accepted symbols and not abbreviations, a period does not follow the metric symbol unless it ends a sentence.

Correct:	10 MG 8 M	Incorrect:	10MG. 8M

2.3 The symbols never reflect plurals, although the spelled out term does.

Correct:	8 CM 46 G 8 LITRES	Incorrect:	8 CMS 46 GS 8 LITRE

2.4 When key punching the unit of measure with a prefix, there is no space or hyphen.

Correct:	MILLIMETRE	Incorrect:	MILLI-METRE

RULE 3: SPECIALIZED USES OF METRIC SYMBOLS AND UNIT NAMES

3.1 Do not combine metric words, symbols, or units in an expression.

Correct:	12 M	Incorrect:	1 000 MM 100 CM 10 M (units)
	KILOWATTS PER HOUR CM/S		KILOWATTS/HR. (words and symbols) CM/SECOND (words and symbols)

3.2 If both Customary and metric measurements are expressed, place the Customary measurement in parentheses after the metric measurement unless otherwise directed.

Correct: 5 MILLILITRES (1 TEASPOON), 1 METRE (3.3 FEET)

3.3 Use either metric or Customary units, but do not combine the expressions.

Correct:	KG/M3	Incorrect:	KG/FT3

RULE 4: MAKE IT METRIC

4.1 The symbol for micro- is made by striking the "U" key.

4.2 To indicate multiplication of metric units, a full stop (.) between the units is necessary.

Correct:	4 N.M	Incorrect:	4 N M, 4 NXM, 4 N X M

4.3 Division is indicated by the use of the solidus "/" or negative exponent. Only one solidus should be used in a compound unit of measure. In doing this, avoid the use of the prefixes in the denominator.

Correct:	CM/S CM.S-1	Incorrect:	$\frac{CM}{S}$

4.4 Both "re" and "er" are correct endings for the words metre/meter and litre/liter. Spell them consistently.

NOTE: The upper-case letters used to represent metric symbols are intended primarily for the use of data processing systems and equipment. Upper-case letters should never be printed out for publication or for other forms of public information. In these cases the special symbols must be replaced by the proper metric symbol or by the full names of the units.

*All rules pertaining to spacing apply to free text (narrative) data. In formatted data, such as in records, the use of a space character is optional since its use or non-use is defined in the format description.

KEY PUNCH IT RIGHT

Quantity	Unit	Plural	Symbol	Special Key Punch Symbol
length	metre	metres	m	M
	centimetre	centimetres	cm	CM
	millimetre	millimetres	mm	MM
	kilometre	kilometres	km	KM
area	square metre	square metres	m^2	M2
	square centimetre	square centimetres	cm^2	CM2
	square millimetre	square millimetres	mm^2	MM2
volume/capacity	cubic metre	cubic metres	m^3	M3
	cubic centimetre	cubic centimetres	cm^3	CM3
	litre	litres	l	L
	millilitre	millilitres	ml	ML
mass	gram	grams	g	G
	kilogram	kilograms	kg	KG
	metric ton	metric tons	t	TNE
temperature	degree Celsius	degrees Celsius	$^\circ C$	CEL
	kelvin	kelvins	K	K
time	day	days	d	D
	hour	hours	h	HR
	minute	minutes	min	MIN
	second	seconds	s	S
velocity	metre per second	metres per second	m/s	M/S
frequency	hertz	hertz	Hz	HZ
	megahertz	megahertz	MHz	MAHZ

Quantity	Unit	Plural	Symbol	Special Key Punch Symbol
force	newton	newtons	N	N
conductance	siemens	siemens	S	SIE
electric current	ampere	amperes	A	A
electric change	coulomb	coulombs	C	C
electric potential	volt	volts	V	V
electric capacitance	farad	farads	F	F
electrical resistance	ohm	ohms	Ω	ØHM
power	watt	watts	W	W
	kilowatt	kilowatts	kW	KW
energy	joule	joules	J	J
	kilojoule	kilojoules	kJ	KJ
illuminance	lux	lux	lx	LX
luminous intensity	candela	candelas	cd	CD
density	kilogram per cubic metre	kilograms per cubic metre	kg/m^3	KG/M3
pressure/stress	pascal	pascals	Pa	PA
	kilopascal	kilopascals	kPa	KPA
amount of substance	mole	moles	mol	MØL
luminous flux	lumen	lumens	lm	LM
magnetic flux	weber	webers	Wb	WB
magnetic inductance	tesla	teslas	T	T
inductance	henry	henries	H	H

***The upper-case letters used to represent metric symbols are intended primarily for the use of data processing systems and equipment. They should never be printed out for publication or for other forms of public information. In these cases the special symbols must be replaced by the proper metric symbol or by the full names of the units.**

KEY PUNCH IN METRIC

Key punch the following text using metric key punch symbols. Proof and verify your cards.

Review the following information and keep it available for easy reference.

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 (g), kilograms (kg), and metric tons (t).

5. A comfortable room temperature will be 20 degrees Celsius (20°C) instead of 68 degrees Fahrenheit. 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), watts (W), ohms (Ω), couloumbs (C), hertz (Hz), amperes (A), and seimens (S).

7. Force will be measured in newtons (N) and energy will be joules (J) instead of calories.

8. Time will remain the same: days (d), hours (h), minutes (min), and seconds (s).

Exercise 15

WRITING METRIC TERMS

Write the following measurements using numbers and special metric symbols for key punching.

a) Ten kilograms ____________

b) Eighty-five millimetres ____________

c) Twenty-seven degrees Celsius ____________

d) Nineteen litres ____________

e) Thirty-seven watts ____________

f) Forty volts ____________

g) Nine centimetres ____________

h) Forty-five amperes ____________

i) Ten webers ____________

j) Eight lux ____________

k) Twenty-five cubic metres ____________

l) Fifteen newton-metres ____________

m) Ten microvolts ____________

n) Five ohms ____________

o) Twenty square metres ____________

p) Two hundred seventy-four kelvins ____________

q) Forty siemens ____________

Exercise 16

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 4.
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 4 on the next page gives an example of a metric-Customary conversion table which you can use for practice in finding approximate equivalents. Table 4 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 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.

CONVERSION TABLES

MILLIMETRES TO CENTIMETRES TO INCHES

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

1000 mm or 1 metre = 39.37 inches

INCHES TO CENTIMETRES TO MILLIMETRES

in.	cm	mm	in.	cm	mm
1	2.54	25.4	1/8	0.32	3.2
2	5.08	50.8	1/4	0.64	6.4
3	7.62	76.2	1/2	1.27	12.7
4	10.16	101.6	3/4	1.91	19.1
5	12.70	127.0			
6	15.24	152.4			
7	17.78	177.8			
8	20.32	203.2			
9	22.86	228.6			
10	25.40	254.0			

12 in. or 1 ft. = 30.48 cm or 304.8 mm

METRES TO FEET

m	ft.	m	ft.	m	ft.
100	328.08	10	32.81	1	3.28
200	656.17	20	65.62	2	6.56
300	984.25	30	98.43	3	9.84
400	1312.34	40	131.23	4	13.12
500	1640.42	50	164.04	5	16.40
600	1968.50	60	196.85	6	19.69
700	2296.59	70	229.66	7	22.97
800	2624.67	80	262.47	8	26.25
900	2952.76	90	295.28	9	29.53
1000	3280.84				

FEET TO METRES

ft.	m	ft.	m	ft.	m
100	30.48	10	3.05	1	0.30
200	60.96	20	6.10	2	0.61
300	91.44	30	9.14	3	0.91
400	121.92	40	12.19	4	1.22
500	152.40	50	15.24	5	1.52
600	182.88	60	18.29	6	1.83
700	213.36	70	21.34	7	2.13
800	243.84	80	24.38	8	2.44
900	274.32	90	27.43	9	2.74
1000	304.80				

ANY WAY YOU WANT IT

1. You are working in a data processing center. With the change to metric measurement, some of the purchase orders you process are marked only in metric units. You will need to be familiar with metric equivalents in order to process the orders. 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) 5 gal. of gas	
b) 2 lbs. of ink	
c) 5 in. tape	
d) 3 ft. deep desk	
e) 5 yds. of ribbon	

2. Use the conversion Table 4 to convert the following:

a) 30 mm =	______ in.	j) 4 in. =	____ mm
b) 750 mm =	______ in.	k) 12 in. =	____ cm
c) 2.5 cm =	______ in.	l) 1/2 in. =	____ mm
d) 88 cm =	______ in.	m) 4 1/4 in. =	____ cm
e) 3 m =	______ ft.	n) 16 1/2 in. =	____ cm
f) 48 m	______ ft.	o) 6 ft. =	____ m
g) 472 mm =	______ in.	p) 85 ft. =	____ m
h) 65.4 cm =	______ in.	q) 20 ft. =	____ m
i) 152 m =	______ ft.	r) 428 ft. =	____ m

3. For the following Purchase Order, verify the metric quantity (use conversion tables and round to nearest unit) and unit of measure (use Table 4). If it is correct, place a check by it. If it is incorrect, show the correction on the Purchase Order. After you have completed this, key punch the Purchase Order and reverify your results. Use your signature as the Purchasing Agent. (Customary quantities appear in parentheses at the end of each item; do not key punch it.)

We Need It Company
971 We Street
Need, OH 43718
(614) 965-8213

PURCHASE ORDER

TO: Super Supply Co.
987 Stone St.
Here, Ohio 43200

Order No. 19789
Ship Via: Express
Date: January 5, 19
Terms: 2/10, n/30

Quantity	Description	Unit Cost	Total
2	a)114 mm trim saw, Model 314 (4 1/2")	$ 89.20	$178.40
1	b)End mill sharpener with 8.9 mm brushings (.35")	107.00	107.00
3	c)Digital outside micrometre 51 mm range, Model 417115 (2")	33.50	100.50
1	d)152 mm standard grinder with guard cover, Model No. 612 (6")	66.00	66.00
2	e)Power hacksaws, cuts 38 mm solids, Model No. 1376 (1 1/2")	240.00	480.00
	TOTAL		$931.40

SEND INVOICE IN DUPLICATE

________________, Purchasing Agent

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. A keypunch ribbon width will be measured in:
   [A] kilometres
   [B] metres
   [C] millimetres
   [D] litres

4. Temperature for the computer equipment area is given in:
   [A] kilograms
   [B] centimetres
   [C] degrees Celsius
   [D] litres

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 card 20 centimetres wide is the same as:
   [A] 2 000 millimetres
   [B] 2 millimetres
   [C] 200 millimetres
   [D] 0.2 millimetre

8. A magnetic tape 25 millimetres wide is the same as:
   [A] 2.5 centimetres
   [B] 0.25 centimetre
   [C] 25.0 centimetres
   [D] 0.025 centimetre

SECTION C

9. Which metric term is misspelled?
   [A] herts
   [B] centimetre
   [C] watt
   [D] Celsius

10. The correct key punch symbol for degree Celsius is:
    [A] °C
    [B] cel
    [C] C
    [D] CEL

11. Which metric term is misspelled?
    [A] pascel
    [B] metre
    [C] volt
    [D] weber

12. The correct key punch symbol for kilograms per cubic metre is:
    [A] kg/m^3
    [B] K/M
    [C] KG/M3
    [D] KG/CM

13. The metric unit which replaces the gallon is:
    [A] litre
    [B] gram
    [C] hectare
    [D] millilitre

14. The metric unit which replaces the foot is:
    [A] litre
    [B] gram
    [C] metre
    [D] millimetre

Use this conversion table to answer questions 15 and 16.

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

15. The equivalent of 15 mm is:
    [A] 0.15 in.
    [B] 0.39 in.
    [C] 0.59 in.
    [D] 1.15 in.

16. The equivalent of 89 mm is:
    [A] 0.89 in.
    [B] 3.50 in.
    [C] 3.15 in.
    [D] 8.90 in.

ANSWERS TO EXERCISES AND TEST

EXERCISE 7

Part 1.

Currently accepted metric units of measurement for each question are shown in Table 3. Standards in each occupation are being established now, so answers may vary.

Part 2.

d, a, b, b

EXERCISE 14

a)	5 m	i)	2 000 mm
b)	0.25 litre	j)	0.5 kg
c)	50 mm	k)	0.5 litre
d)	2.5 kg	l)	500 kg
e)	12 cm	m)	1 000 cm
f)	250 ml	n)	35 mm
g)	2 t	o)	240 cm
h)	500 ml		

EXERCISE 15

1. MM, CM, M, KM, KM/HR
2. CM2, M2
3. ML, L, KL
4. G, KG, TNE
5. 20 CEL
6. V, H, WB, F, W, ØHM, C, HZ, A, SIE
7. N, J
8. D, HR, MIN, S

EXERCISE 16

a)	10 KG	j)	8 LX
b)	85 MM	k)	25 M3
c)	27 CEL	l)	15 N.M
d)	19 L	m)	10 UV
e)	37 W	n)	5 ØHM
f)	40 V	o)	20 M2
g)	9 CM	p)	274 K
h)	45 A	q)	40 SIE
i)	10 WB		

EXERCISE 17

Part 1.

a) 18.95 litres
b) 0.9 kg
c) 12.7 cm
d) 0.915 m
e) 4.55 m

Part 2.

a)	1.18 in.	j)	101.6 mm
b)	29.53 in.	k)	30.48 cm
c)	0.99 in.	l)	12.7 mm
d)	34.65 in.	m)	10.8 cm
e)	9.84 ft.	n)	41.91 cm
f)	157.48 ft.	o)	1.83 m
g)	18.58 in.	p)	25.9 m
h)	25.75 in.	q)	6.1 m
i)	498.68 ft.	r)	130.46 m

Part 3.

a) 114 mm
b) 8.9 mm
c) 51 mm
d) 152 mm
c) 38 mm

TESTING METRIC ABILITIES

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

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Tools and Devices List

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

REFERENCES

Information Processing—Representations of SI and Other Units for Use in Systems with Limited Character Sets. International Organization for Standardization, First Edition, 1974, 4 pages, Ref. No. ISO2955-1974. Available from: American National Standards Institute, 1430 Broadway, New York, NY 10018, write for price.

This International Standard manual provides symbols for units to be used in data processing systems in place of common SI symbols. Rules, definitions and charts are also included in the manual.

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, pronunciation, 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.

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.