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ABSTRACT

Designed to meet the job-related metric measurement needs of bindery operations students, this instructional package is one of six for the communication media 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, measurement 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 occupation 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 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, a skill considered useful during the transition to metric in each occupation. (HD)

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THE CENTER FOR VOCATIONAL EDUCATION

TEACHING AND LEARNING THE METRIC SYSTEM

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

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

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

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

Unit 1 is a general introduction to the metric system of measurement which provides informal, hands-on experiences for the students. This unit enables students to become familiar with the basic metric units, their symbols, and measurement instruments; and to develop a set of mental references for metric values. The metric system of notation 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 also was designed to accommodate a variety of individual teaching and learning styles. Teachers are encouraged to adapt these materials to their own classes. For example, the information sheets may be given to students for self-study. References may be used as supplemental resources. Exercises may be used in independent study, small groups, or whole-class activities. All of the materials can be expanded by the teacher.

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Joel H. Magisos
Editors

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UNIT 1

SUGGESTED TEACHING SEQUENCE

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

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

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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.

Information Sheet 1

METRIC UNITS, SYMBOLS, AND REFERENTS

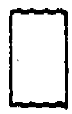
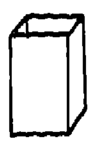
Quantity	Metric Unit	Symbol	Useful Referents
Length	millimetre	mm	Thickness of dime or paper clip wire
	centimetre	cm	Width of paper clip
	metre	m	Height of door about 2 m
	kilometre	km	12-minute walking distance
Area	square centimetre	cm^2	Area of this space 
	square metre	m^2	Area of card table top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

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Table 1–a

METRIC PREFIXES

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

Table 1–b

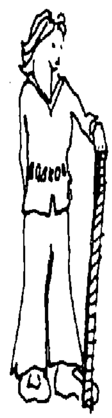
LINEAR MEASUREMENT ACTIVITIES

Metre, Centimetre, Millimetre

I. THE METRE (m)

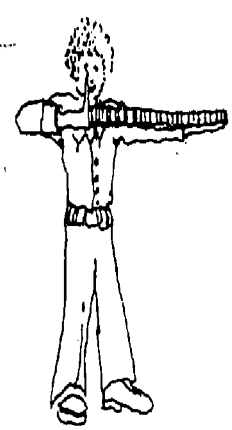
A. DEVELOP A FEELING FOR THE SIZE OF A METRE

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



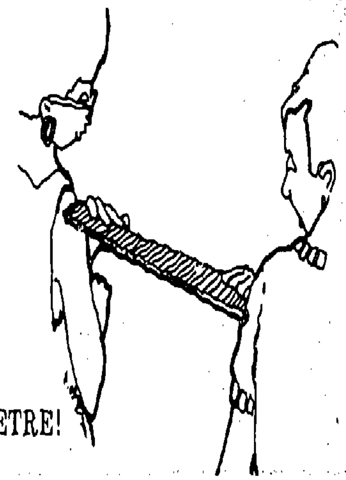
THAT IS HOW HIGH A METRE IS!

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



THAT IS HOW LONG A METRE IS!

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



THAT IS THE WIDTH OF A METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN METRES

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

For each of the following items:

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

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

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

Exercise 1

(continued on next page)

II. THE CENTIMETRE (cm)

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

A. DEVELOP A FEELING FOR THE SIZE OF A CENTIMETRE

1. Hold the metric ruler against the width of your thumbnail. How wide is it? ______ cm
2. Measure your thumb from the first jo[illegible] ______ 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 ... e the grid on page 6.
2. Measure the length ... d width ... one of these small squares with a centim...

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 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.	_____	_____	_____

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Exercise 5

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.

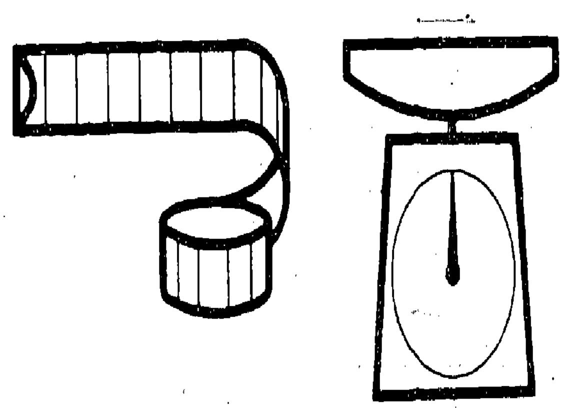
4. Have students learn occupationally-related metric measurements by completing Exercises 6 and 7.

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 BINDERY OPERATION

Quantity	Unit	Symbol	Use
Length	millimetre	mm	Wrapping paper and cellophane, wire roll, paper
	centimetre	cm	Padding tape, ring binders, covers, wire-staple size
Mass	gram	g	Padding cement, postage
	kilogram	kg	Supplies, shipping, postage
Volume/Capacity	millilitre	ml	Padding cement, oil
	litre	l	
	cubic centimetre	cm^3	Storage and shipping space
	cubic metre	m^3	
Pressure	kilopascal	kPa	Air pressure and vacuum settings
Temperature	degree Celsius	°C	Room, solution, or storage temperatures, glue
Application rates	millilitres per square metre	ml/m^2	Estimating materials needed and applying materials
	grams per square metre	g/m^2	

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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.

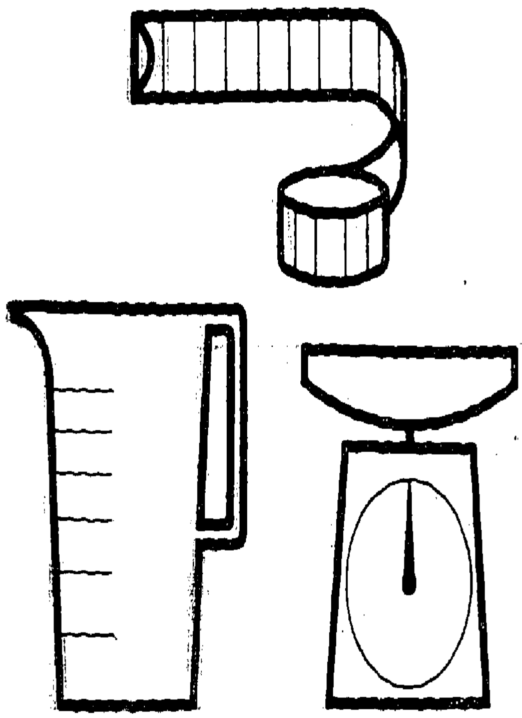
	Estimate	Actual
Length		
1. Palm width		
2. Hand span		
3. Your height		
4. Height of lab cutter		
5. Space between holes on standard 3-hole punch		
6. Maximum cut on lab cutter		
7. Maximum width on lab cutter		
8. Cutter knife on lab cutter		
9. Width of a plastic spine		
Area		
10. Desk top		
11. Classroom floor		
12. Steel bindery table		
13. Floor space of lab cutter		
14. Sheet of paper		

	Estimate	Actual
Volume/Capacity		
15. Small bottle		
16. Measuring cup (metric)		
17. Milk container		
18. Jug		
19. Bucket		
20. Small box or package		
21. Carton of No. 10 envelopes		
22. Carton of 6 3/4 envelopes		
Mass		
23. Textbook		
24. Nickel		
25. Yourself		
26. Paper clip		
27. A quantity of bond paper		
28. A litre of water (net)		
Temperature		
29. Bindery lab		
30. Outside		
31. Hot tap water		
32. Storage space		

BINDING WITH METRICS

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

1. Height of a skid of paper	
2. Amount of stitcher wire to be used for a book (2 stitches per book)	
3. Application rate of padding compound	
4. Cutter clamp pressure for NCR paper	
5. Capacity of carton for 8 reams bond paper	
6. Length of strip to tin calender	
7. Thickness of 250 page book	
8. Height of 750 sheets of 4 ply blanks	
9. Length of mailing tube	
10. Capacity of drum hot-melt glue	
11. Setting a folder for a center fold of a 19 cm x 29 cm page	
12. Determine the capacity of a wire stitcher	
13. Determine the maximum hole size of a paper drilling machine	
14. Selecting the correct size and type of tape for doing a book-binding machine job	
15. Measuring the dimensions of a paper cutter:	
a. Cutting width	
b. Cutting thickness	
c. Table space	
16. Selecting the correct drill size for drilling holes for a standard ring binder	
17. Setting up a punch for standard three hole punching	



UNIT 3

OBJECTIVE

The student will recognize and use metric equivalents.

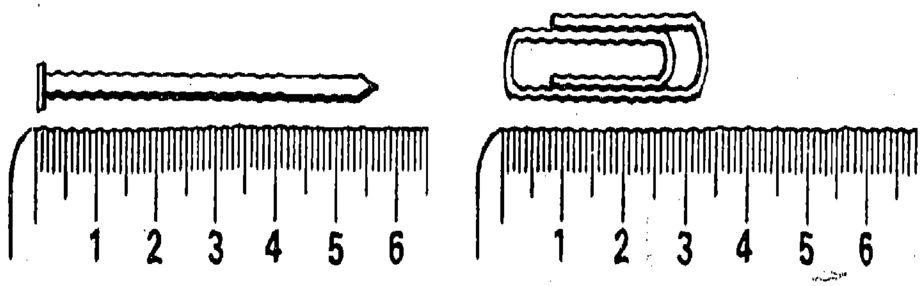
- Given a metric unit, state an equivalent in a larger or smaller metric unit.

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) 45.72 m gold stamp foil is ______________ cm
b) 250 ml of padding compound is ______________ l
c) 5 cm diameter die cut circle is ______________ mm
d) 2 500 g of metal eyelets is ______________ kg
e) 120 mm wide strip of card stock is ______________ cm
f) 0.25 litre of liquid glue is ______________ ml
g) 2 000 kg of paper is ______________ t
h) 10 m roll of tape is ______________ cm
i) 0.5 litre of concentrate is ______________ ml
j) 2 cm staple is ______________ mm
k) 280 mm paper is ______________ cm
l) 600 mm poster board is ______________ cm
m) 500 kg of cover stock is ______________ t
n) 4 litre of padding compound is ______________ ml

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 25% and measure within 5% accuracy.

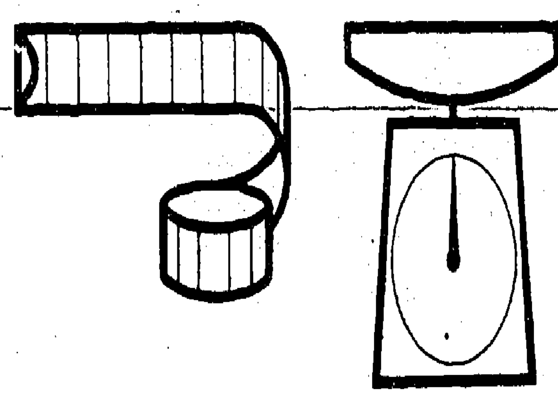
SUGGESTED TEACHING SEQUENCE

1. Assemble metric and Customary measuring tools and devices (rules, scales, °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 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 tractor 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.
6. Some products may have a special metric symbol such as a block M to show they are metric.
7. Don't force devices which are not fitting properly.
8. Practice selecting and using tools, instruments, and devices.



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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.

1. Measure odd size stack of scrap paper.
2. Order cartons to package customer order of cut paper.
3. Determine caliper of sheet of book paper.
4. Estimate stitcher wire needed for large book order.
5. Determine mass of skid of book paper.
6. Estimate storage space for 10 skids of book paper.
7. Figure postage required to mail catalog order.
8. Determine amount of oil for hydraulic pump on cutter.
9. Determine number of bales of scrap paper that can be hauled in shop truck.
10. Determine temperature of paper storage area.
11. Select the correct fold dimensions for folding a form business letter.
12. Determine the number of pages that can be stapled on a stitcher.
13. Determine amount of padding cement required for a large multiple form order.

Exercise 15

MEASURING UP IN BINDERY OPERATIONS

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. Mass (weight) of stack of scrap paper		
2. Surface area of steel bindery tables		
3. Temperature of:		
a. Bindery		
b. Outside		
c. Paper storage area		
4. Height of cutter bed		
5. Volume of scrap storage bin		
6. The spacing of holes drilled in sheet of paper		
7. Area needed for skid of paper		
8. Size of jar of padding compound in millilitres		
9. Estimated cm of gold stamp foil to be used in stamping 1000 book covers (15.24 cm by 5.08 cm of foil to be used per book)		
10. Estimate number of book covers that can be stamped from 1 roll of gold stamp foil 15.24 cm x 50 m (15.24 cm x 5.08 cm to be used per book)		
11. Select size and number of lengths of mailing tubes needed to mail 600 calendars 90 cm x 7.6 cm when rolled (mailing tubes available in 2.75 m lengths)		

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 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 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 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	.25	.001	.03
2	50.8	0.2	5.08	.02	.51	.002	.05
3	76.2	0.3	7.62	.03	.76	.003	.08
4	101.6	0.4	10.16	.04	1.02	.004	.10
5	127.0	0.5	12.70	.05	1.27	.005	.13
6	152.4	0.6	15.24	.06	1.52	.006	.15
7	177.8	0.7	17.78	.07	1.78	.007	.18
8	203.2	0.8	20.32	.08	2.03	.008	.20
9	228.6	0.9	22.86	.09	2.29	.009	.23

10 inches = 254 mm

12 inches or 1 feet = 304.8 mm or 30.48 cm

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Table 3

ANY WAY YOU WANT IT

1. You are working in a bindery. 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) 5000 lbs. of book paper	
b) 4 qts. of padding compound	
c) 3/4 in. die cut	
d) 1 sq. yd.	
e) 50 lbs. of stitcher wire	
f) 18 in. tinning strip	
g) ~~two~~-gallon can	
h) 1/2 lb. shipping mass (weight)	
i) 1/4 lb. of rubber bands	
j) 4 in. card stock	
k) 24 in. poster board	
l) 2 miles	
m) 15 yd. roll of tape	
n) 40 lbs. box of paper	
o) 1/2 in. margin	

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

a) 0.003 in. = ____________ mm
b) 18 in. = ____________ mm
c) 100 mm = ____________ in.
d) 605 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.). Order the following bindery supplies:

a) 1 gal. of padding cement
b) 5 rolls of 2 in. by 25 yd. roll of black bookbinding tape
c) 1 box of 5M 1/2 in. staples
d) 1 package of 5 sheets, 22 in. x 28 in. heavy binder board

REQUISITION

Date ____________

For ____________________

____

Job No. ____________ Date Wanted ____________

Deliver to ____________________

QTY	UNIT	ITEM

Requested by ____________________

Approved by ____________________

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 metric unit which is used to measure paper thickness is:

[A] gram

[B] millimetre

[C] kilogram

[D] milligram

4. The mass of brass eyelets is measured in:

[A] cubic metres

[B] millilitres

[C] centimetres

[D] kilograms

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 sheet of paper 20 centimetres wide also has a width of:

[A] 2 000 millimetres

[B] 0.2 millimetre

[C] 2 millimetres

[D] 200 millimetres

8. A 750 gram box of fasteners is the same as:

[A] 7.5 kilograms

[B] 0.75 kilogram

[C] 7 500 kilograms

[D] 750 000 kilograms

SECTION C

9. For measuring grams you would use a:

[A] rule

[B] pressure gage

[C] scale

[D] container

10. For measuring millimetres you would use a:

[A] pressure gage

[B] ruler

[C] scale

[D] container

11. Estimate the length of the line segment below:

[A] 23 grams

[B] 6 centimetres

[C] 40 millimetres

[D] 14 pascals

12. Estimate the length of the line segment below:

[A] 10 millimetres

[B] 4 centimetres

[C] 4 pascals

[D] 23 milligrams

SECTION D

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

[A] litre

[B] millilitre

[C] hectare

[D] gram

14. The metric unit for liquid measure which replaces the gallon is:

[A] gram

[B] kilogram

[C] kilolitre

[D] litre

Use this conversion table to answer questions 15 and 16.

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

15. The equivalent of 290 mm is:

[A] 12.00 in.

[B] 29.32 in.

[C] 7.87 in.

[D] 11.41 in.

16. The equivalent of 460 mm is:

[A] 12.34 in.

[B] 11.41 in.

[C] 18.10 in.

[D] 24.00 in.

ANSWERS TO EXERCISES AND TEST

EXERCISES 1 THRU 6

The answers depend on the items used for the activities.

EXERCISE 7

Currently accepted metric units of measurement for each question are shown in Table 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)	4 572 cm	h)	1 000 cm
b)	0.25 litre	i)	500 ml
c)	50 mm	j)	20 mm
d)	2.5 kg	k)	28 cm
e)	12 cm	l)	60 cm
f)	250 ml	m)	0.5 t
g)	2 t	n)	4 000 ml

EXERCISES 15 AND 16

The answers depend on the items used for the activities.

EXERCISE 17

Part 1.

a)	2 250 kg	i)	0.113 kg
b)	3.8 litres	j)	10.16 cm
c)	1.905 cm	k)	60.96 cm
d)	0.8 m^2	l)	3.22 km
e)	22.5 kg	m)	13.65 m
f)	45.72 cm	n)	18 kg
g)	7.58 litres	0)	1.27 cm
h)	0.225 kg		

Part 2.

a)	0.08 mm	c)	3.93 in.
b)	457.2 mm	d)	23.82 in.

Part 3.

a) 3.79 litres
b) 5 - 5.08 cm by 22.75 m
c) 1 - 1.27 cm
d) 1 - 55.88 cm x 71.12 cm

TESTING METRIC ABILITIES

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

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SUGGESTED METRIC TOOLS AND DEVICES
NEEDED TO COMPLETE MEASUREMENT TASKS
IN EXERCISES 1 THROUGH 5

(* Optional)

LINEAR

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

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

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

TEMPERATURE

Celsius Thermometer

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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.

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.

Going Metric with the U.S. Printing Industry. Clive A. Cameron, Graphic Arts Research Center, Rochester Institute of Technology, Rochester, NY 14623, 1972, 175 pages, $8.70, paper.

Book on metric conversion for printing and graphics industry. Chapters on evolution of measurement; commentary on conversions in Britain and Japan; metric systems applications in paper and packaging, typesetting, and machinery and equipment; also has findings of survey on attitudes of graphic arts firms toward the metric standard. Has related tables and graphics.

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.

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.

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.

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

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

INFORMATION SOURCES

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

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

Metric Committee, National Association of Photographic Manufacturers, 600 Mamaroneck Avenue, Harrison, NY 10528

Trade association which is establishing product standards, recommended practices for the use of measurement units, and coordinating metric change-over in the industry.

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.