This learning activity package on using the metric system is one of a series of 12 titles developed for use in health occupations education programs. Materials in the package include objectives, a list of materials needed, information sheets, reviews (self evaluations) of portions of the content, and answers to reviews. These topics are covered: metric system history, metric system rules, metric system tools, and measuring volume, mass, length, and temperature. (YLB)
Using The Metric System
In Health Careers
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In Health Careers

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OBJECTIVES

AFTER COMPLETING THIS LAP, YOU WILL BE ABLE TO DO THE FOLLOWING:

1. Briefly describe the history of the metric system.
2. Explain six advantages of the metric system.
3. List eight rules of the metric system.
4. Define the units and prefixes used in the metric system.
5. List the common tools of the metric system used for linear, volume, and weight measurements.
6. Calculate common metric measurements, including volume, mass, and length.
7. Convert Fahrenheit temperature to Celsius.

MATERIALS NEEDED

* WORK SHEET
  PEN OR PENCIL

* Pick up a work sheet before beginning this lap.
METRIC SYSTEM
HISTORY

The metric system was adopted in France in 1790 as a universal system of weights and measures. It was made legal in the United States in 1866.

Some opponents of the metric system in the United States based their opposition on the belief that the inch was derived from the cubit referred to in the Bible. Other opponents were convinced that the introduction of the metric system was the result of a foreign conspiracy.

Industry has opposed the use of the metric system because of costs and complications in the changeover in tools and machinery.

The Metric Conversion Act of 1975 provided for a Metric Board to oversee the changeover in the United States from the English system to the metric system.

Ninety percent of the world now uses the metric system. It is called the International System of Units (SI) and is based on an international agreement in 1960.
As civilization grew, there was a need to measure goods, commodities, building materials, and distances. This led to the creation of different measuring systems. Hodgepodge measuring methods and devices were established. Available "measures" were used; these include:

- A man's stride
- An arm's length
- Handfuls
- Foot
METRIC SYSTEM
HISTORY

REVIEW I.

DO YOU REMEMBER?

1. Why does industry resist changing to the metric system?
2. How were measuring systems originally started?
3. How much of the world is now using the metric system?
4. When was the metric system made legal in the United States?

Answers are on the next page.
If you got all of the questions right, continue on.
If not, go back and review.
REVIEW 1. ANSWER KEY

1. COSTS AND COMPLICATIONS OF TOOLS AND MACHINERY

2. HODGEPODGE, USING AVAILABLE MEASURES LIKE A MAN’S STRIDE OR ARM’S LENGTH OR HANDFULS OR "FOOT."

3. 90 PERCENT

4. 1866
METRIC SYSTEM

ADVANTAGES

10

All units of measure are multiples or submultiples of 10.

One set of prefixes is used for all types of measures.

KILO
HECTO
DEKA

DECI
CENTI
MILLI

Conversion to the metric system would be better for import/export.

Health services already use the metric system.

Fewer more sensible sizes.
METRIC SYSTEM
ADVANTAGES

Greater ease in comparing prices

Easier to calculate

Many countries use already
METRIC SYSTEM
ADVANTAGES

REVIEW II.

DO YOU REMEMBER?

1. What service in the U.S. already uses the metric system?

2. How many sets of prefixes are used for all types of measures?

3. What number is very important in doing multiples in the metric system?

Answers are on the next page.
If you got all of the questions right, continue on.
If not, please go back and review.
REVIEW II. ANSWER KEY

1. HEALTH SERVICES

2. 1

3. 10
### METRIC SYSTEM

#### UNITS YOU NEED TO KNOW:

<table>
<thead>
<tr>
<th>UNIT</th>
<th>SYMBOL</th>
<th>MEASURES</th>
<th>REPLACES</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER</td>
<td>m</td>
<td>length, distance, thickness</td>
<td>inch, foot, yard,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mile</td>
</tr>
<tr>
<td>GRAM</td>
<td>g</td>
<td>weight</td>
<td>ounce, pound</td>
</tr>
<tr>
<td>LITER</td>
<td>L</td>
<td>volume</td>
<td>cup, pint, quart,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>gallon, fluid ounce</td>
</tr>
<tr>
<td>CELSIUS</td>
<td>°C</td>
<td>temperature</td>
<td>Fahrenheit,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Centigrade</td>
</tr>
<tr>
<td>AMPERE</td>
<td>A</td>
<td>electrical current</td>
<td>no change</td>
</tr>
<tr>
<td>WATT</td>
<td>W</td>
<td>power</td>
<td>no change</td>
</tr>
</tbody>
</table>

**NOTE:** Other English-speaking countries use the spelling: metre and litre.
## Metric System

### Prefixes Commonly Used:

<table>
<thead>
<tr>
<th>More Than One of a Unit</th>
<th>Prefix</th>
<th>Symbol</th>
<th>Relation to Unit</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilo-</td>
<td>k</td>
<td></td>
<td>1000 of them</td>
<td>1 kilogram</td>
</tr>
<tr>
<td>Hecto-</td>
<td>h</td>
<td></td>
<td>100 of them</td>
<td>1 hectometer</td>
</tr>
<tr>
<td>Deci-</td>
<td>d</td>
<td></td>
<td>1/10 of unit</td>
<td>1 deciliter</td>
</tr>
<tr>
<td>Centi-</td>
<td>c</td>
<td></td>
<td>1/100 of unit</td>
<td>1 centimeter</td>
</tr>
<tr>
<td>Milli-</td>
<td>m</td>
<td></td>
<td>1/1000 of unit</td>
<td>1 milliliter</td>
</tr>
</tbody>
</table>
REVIEW III.

DO YOU REMEMBER?

1. THE METER MEASURES ___________________________ AND THE SYMBOL FOR IT IS __________.

2. THE METRIC UNIT FOR WEIGHT IS CALLED ___________________________

3. THE LITER MEASURES ___________________________, AND REPLACES __________

4. THE METRIC TEMPERATURE UNIT IS CALLED __________________________

5. AMPERE DENOTES ___________________________ AND WATT MEANS __________

6. TWO PREFIXES THAT DENOTE MORE THAN ONE OF A UNIT ARE __________ AND __________

7. MATCH THE FOLLOWING:

   _______MILLI-   A. 1/100 OF UNIT
   _______KILO-    B. 1/1000 OF UNIT
   _______CENTI-   C. 100 OF THEM
   _______DECI-    D. 1000 OF THEM
   _______HECTO-   E. 1/10 OF UNIT

Answers are on next page.

If you got them all right, continue on.

If not, go back and review.
REVIEW III. ANSWER KEY

1. LENGTH OR DISTANCE OR THICKNESS  
m
2. A GRAM OR KILOGRAMS
3. VOLUME  
   CUP OR PINT OR QUART OR GALLON OR FLUID OUNCE
4. CELSIUS
5. ELECTRICAL CURRENT  
   POWER
6. KILO-  
   HECTO-
7. B.
   D.
   A.
   E.
   C.
METRIC SYSTEM

Rules to Follow:

1. Use a space, not a comma, for writing numbers.

2. A zero precedes the decimal point if the number is less than 1.

3. Symbols are not plural, no matter how many.

4. Leave a space between the number and the symbol, except for temperature (e.g., 13°C).

5. Symbols are not followed by periods.

6. Capital letters and small letters are not interchangeable. For example, C is the symbol for centi and °C is the symbol for degree Celsius.

7. When both the metric system and customary units are used, show nonmetric units in parentheses.


Note: In the metric system an upper case letter may mean something different from the lower case letter. For example, mm for millimeter (width of a dime), and Mm for megameter (a thousand kilometers).
The meter is the base unit of length in the metric system. Each unit has a standard which can be reproduced in a laboratory with great accuracy—to 8 decimal places and more.

**Examples of Rules to Follow**

- Use a space, not a comma, for writing numbers.

  **Correct**
  
  53 471
  2 600.5
  1.051 07
  
  **Incorrect**
  
  $3,471$
  2,600.5
  1.051,07

  **NO**

  A zero precedes the decimal point if the number is less than 1.

  **Correct**
  
  0.560
  0.017
  
  **Incorrect**
  
  .560
  .017
METRIC SYSTEM

Rules to Follow...

Symbols are not plural, no matter how many.

CORRECT
m (meters)
g
kl

INCORRECT
ms (millisecond)
gs
kl

NO "S"

Leave a space between number and symbol.

CORRECT
25 mg
1.050 mm
0.5 L

INCORRECT
25mg
1.050mm
0.5L

SPACE.
METRIC SYSTEM

Rules to Follow....

Symbols are NOT followed by periods
(to avoid confusion with decimal points).

Correct:
- 25 m
- 370 kg
- 250 cm

Incorrect:
- 25 m
- 370 kg
- 250 cm

All symbols are small letters, except for liter is "L".
(lower case l looks like a number 1.)
METRIC SYSTEM.

Rules to follow...

When both metric and English units are used, show the nonmetric units in parentheses.

Correct
76.2 mm (3 in.)
450 kg (990 lb.)
5 mL (0.17 oz.)

Incorrect
76.2 mm - 3 in.
990 lbs. (450 kg)
5 mL - 0.17 oz.

Use ( )

Avoid common fractions. Use decimal fractions for quantities fewer than one.

Correct
0.25 mg
3.50 km

Incorrect
\frac{1}{4} mg
3.5 km

No \frac{1}{4}
METRIC SYSTEM

REVIEW IV.

Do you remember the rules?

Mark the following examples either right or wrong and briefly explain which rule has been violated.

1. 2,000,011
2. 0.017
3. ms
4. 25mg
5. 25 m.
6. m
7. 5 ml (0.17 oz.)
8. ¼ mg
9. 53 471
10. 0.5L

Answers are on the next page.

If you got them all right, continue on.

If not, go back and review.
REVIEW IV.  ANSWER KEY

1. Wrong........................................... NO COMMAS
2. Right.............................. ZERO PRECEDES DECIMAL IF LESS THAN 1.
3. Wrong........................................... NO PLURALS SHOULD BE USED.
4. Wrong........................................... LEAVE SPACE BETWEEN NUMBER AND SYMBOL.
5. Wrong........................................... SYMBOLS ARE NOT FOLLOWED BY A PERIOD.
6. Right........................................... SYMBOLS ARE SMALL LETTERS.
7. Right............................... BOTH SYSTEMS USED, NONMETRIC IN PARENTHESES
8. Wrong........................................... NO FRACTIONS
9. Right........................................... NO COMMAS
10. Wrong........................................... NO SPACE BETWEEN NUMBER AND SYMBOL
TOOLS OF THE TRADE

LINEAR MEASUREMENTS

METERSTICK...OR...TAPE...OR...RULER...

VOLUME

MEASURING CUP OR GRADUATE

WEIGHT OR MASS

SCALES
METRIC SYSTEM

TEMPERATURE

THERMOMETER IN CELSIUS (CENTIGRADE)

AVERAGE NORMAL BODY TEMPERATURE

NORMAL BODY TEMPERATURE IS 37°C.

MEDICAL MEASURING

IN DOCTORS' OFFICES, SCALES ARE GENERALLY IN POUNDS AND NEED TO BE CONVERTED TO KILOGRAMS.

MEDICATIONS ARE ALREADY CONVERTED TO THE METRIC SYSTEM.

BLOOD PRESSURE IS ALREADY IN MILLIMETERS OF MERCURY.

WEIGHT CONTROL DIETS ARE DESIGNED FOR GRAMS PER DAY.
DO YOU REMEMBER?

1. What units should appear on scales for measuring weight or mass?
2. What is the medical term for a measuring cup?
3. What does the meterstick replace?
4. The normal body temperature in the metric system is _____.

Answers are on the next page.
If you got them all right, continue on.
If not, go back and review.
1. Grams or kilograms
2. Graduate
3. Ruler or yardstick
4. 37°C
**MEASURING VOLUME**

**CUBIC CENTIMETER (cc)**
- Liquid measure
- Small amounts

**EXAMPLES....**

**LITER (L)**
- Liquid measure
- Larger amounts

**EXAMPLES....**

### METRIC SYSTEM

#### OR MILLILITER (mL)

<table>
<thead>
<tr>
<th>APPROXIMATE</th>
<th>ACTUAL</th>
<th>EQUALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mL</td>
<td>1 mL</td>
<td>1/4 TEASPOON</td>
</tr>
<tr>
<td>15 mL</td>
<td>14 mL</td>
<td>1 TABLESPOON</td>
</tr>
<tr>
<td>30 mL</td>
<td>29 mL</td>
<td>1 OUNCE</td>
</tr>
<tr>
<td>500 mL</td>
<td>480 mL</td>
<td>1 PINT</td>
</tr>
<tr>
<td>1000 mL</td>
<td>960 mL</td>
<td>1 QUART</td>
</tr>
<tr>
<td>4000 mL</td>
<td>3840 mL</td>
<td>1 GALLON</td>
</tr>
</tbody>
</table>

**AN 8 OUNCE GLASS OF MILK EQUALS 240 mL.**

**HALF OF A PINT IS 250 mL.**

**A HALF GALLON OF MILK IS 2000 mL.**

**ONE TEASPOON OF LIQUID IS 4 mL.**

**A 4 OUNCE GLASS OF JUICE IS 120 mL.**

**A 6 OUNCE CUP OF COFFEE IS EQUAL TO 180 mL.**

**1 L EQUALS 1.06 QUART.**

**THE AVERAGE LARGE BOTTLE OF COLA IS 2 LITERS.**

**NOTE:** Although "cc" is commonly used in the United States for cubic centimeters, the international symbol is "cm³" and may be used interchangeably with "mL."
REVIEW VI.

DO YOU REMEMBER?

1. **Smaller liquid measures are measured in** ____________ **while larger amounts are measured in** ____________. 

2. **What is the metric liquid measurement of a large bottle of cola?** ____________. 

3. **Calculate the following to cubic centimeters:**
   - A. 2 ounces of eggnog is ____________
   - B. 7 ounces of pineapple juice is ____________
   - C. 5½ ounces of water is ____________
   - D. 1 pint of alcohol is ____________
   - E. 2 teaspoons of medicine is ____________
   - F. 3 gallons of chocolate milk is ____________
   - G. 6½ ounces of soup is ____________
   - H. 1½ pints is ____________

4. **Another name for cubic centimeter is** ____________. 

**Answers are on the next page.**

**If you got them all right,** *continue on.*

**If not,** go back and review.
REVIEW VI. ANSWER KEY

1. CUBIC CENTIMETERS (cc) LITER (L)

2. 2 LITERS

3. A. 60
   B. 210
   C. 165
   D. 500
   E. 8
   F. 12 000
   G. 195
   H. 750

4. MILLILITER (mL)
MEASURING MASS

MILLIGRAM (mg)

- A very small quantity of mass
- About 1 grain of salt
- Used in chemistry and medicine

GRAM (g)

- Small weights
- 1 g equals 0.035 ounce
- 1 ounce equals 30 g

$5\,\text{¢}$

5 g

1 g

3 aspirin tablets

50 g
MEASURING MASS

🌟 KILOGRAM (kg)
  - MEDIUM WEIGHTS
  - 1 kg EQUALS 2.2 POUNDS

🌟 METRIC TON (t)
  - HEAVY WEIGHTS
  - 1 t EQUALS 1.1 U.S. TONS
REVIEW VII.

DO YOU REMEMBER?

1. SMALL WEIGHTS IN THE METRIC SYSTEM ARE MEASURED IN ________.

2. KILOGRAMS ARE USED TO MEASURE ________WEIGHTS.

3. AUTOMOBILES ARE WEIGHED IN METRIC ________.

4. CALCULATE THE FOLLOWING:
   A. 3 \text{ kg} \text{ EQUAL} \underline{\quad} \text{ POUNDS}.
   B. 6 \underline{\quad} \text{ OUNCES}.
   C. 0.070 \underline{\quad} \text{ OUNCES} \text{ EQUAL} \underline{\quad} \text{ g}.
   D. 4.4 \underline{\quad} \text{ POUNDS} \text{ EQUAL} \underline{\quad} \text{ kg}.

5. A VERY SMALL QUANTITY OF WEIGHT, LIKE A GRAIN OF SALT, IS CALLED ________.

Answers are on the next page.

If you got them all right, continue on.

If not, go back and review.
REVIEW VII

1. GRAMS (g)
2. MEDIUM
3. TONS
4. A. 6.6
   B. 0.210
   C. 2
   D. 2
5. MILLIGRAM (mg)
MEASURING LENGTH

**MILLIMETER (mm)**
- SMALL DIMENSION
- 1 INCH OR LESS
- 1 mm EQUALS 0.04 INCH

**CENTIMETER (cm)**
- DAILY PRACTICAL USE
- 30 cm EQUAL 1 FOOT

- one mm
  - The thickness of a dime

- one mm
  - The thickness of a pumpkin seed

- one mm
  - The diameter of wire of a paper clip
METRIC SYSTEM

USE THIS PIECE OF PAPER WITH THE MEASURING EDGE TO MEASURE THE ITEMS ON THE FOLLOWING PAGE.
METRIC SYSTEM

PRACTICE USING THE CENTIMETER (cm)

ACTUAL MEASURE (WRITE ON WORKSHEET)

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

ESTIMATE MEASUREMENTS

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ cm</td>
<td>________ cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ cm</td>
<td>________ cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ cm</td>
<td>________ cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ mm</td>
<td>________ mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ mm</td>
<td>________ mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ mm</td>
<td>________ mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>________ mm</td>
<td>________ mm</td>
</tr>
</tbody>
</table>

PRACTICING THE MILLIMETER (mm)

ACTUAL MEASURE

1. The width of your fingernail ________ mm

2. Your thumb from the first joint to the end ________ mm

3. The width of your palm ________ mm

4. Your index or pointing finger ________ mm
ESTIMATE MEASUREMENTS

1. LENGTH OF YOUR PENCIL
   Estimate: ___ mm  Actual: ___ mm

2. WIDTH OF A SHEET OF PAPER
   Estimate: ___ mm  Actual: ___ mm

3. WIDTH OF YOUR SHOE SOLE
   Estimate: ___ mm  Actual: ___ mm

TAKE YOUR ANSWERS TO YOUR INSTRUCTOR TO SEE IF YOU HAVE CALCULATED CORRECTLY.
MEASURING LENGTH

* METER (m)
  * LARGER MEASUREMENTS
  * 1 mm EQUALS 39.37 INCHES.

* KILOMETER (km)
  * GREATER DISTANCES
  * 1 km EQUALS 0.6 MILES.

George Washington Bridge
MEASURING TEMPERATURE

Celsius
100
37
0

VS
WATER BOILS
NORMAL BODY TEMP.
WATER FREEZES
Fahrenheit
212
98.6
32

Heat wave: 40°C
Room Temperature: 20°C
Safe Skating: -20°C
Very, Cold: -40°C

98.6°F
Normal body temperature

37°C
36°C
35°C

41°C
40°C
39°C
38°C
37°C

High fever
Significant fever
Low-grade fever

Water boils: 212°F
Water freezes: 32°F

Normal body temperature: 98.6°F
TEMPERATURE CONVERSIONS

To change Fahrenheit to Celsius, subtract 32, then multiply by 5/9.

EXAMPLES:

THE F TEMPERATURE IS 98.6

\[ \frac{98.6 - 32.0}{66.6} \]

THEN,...

\[ \frac{66.6}{1} \times \frac{5}{9} = \frac{333.0}{9} = 37^\circ C \]

THE F TEMPERATURE IS 100.4

\[ \frac{100.4 - 32.0}{68.4} \]

THEN,...

\[ \frac{68.4}{1} \times \frac{5}{9} = \frac{342.0}{9} = 38^\circ C \]

THE F TEMPERATURE IS 102.0

\[ \frac{102.0 - 32.0}{70.0} \]

THEN,...

\[ \frac{70}{1} \times \frac{5}{9} = \frac{350}{9} = 38.8^\circ C \]
METRIC SYSTEM

REVIEW VIII.

DO YOU REMEMBER?

1. What is the normal body Celsius temperature?

2. Water freezes at _________ degree Celsius.

3. 100 degree Celsius is when ________________

4. Calculate the following:
   A. 99.2°F. to ______ C
   B. 103.4°F. to ______ C
   C. 98.2°F. to ______ C
   D. 102.6°F. to ______ C
   E. 101.8°F. to ______ C

Answers are on the next page.
If you got them all right, continue on.
If not, go back and review.
REVIEW VIII.  

ANSWER KEY

1. 37 degrees

2. 0

3. water boils

4. a. 99.2
   \[ \frac{-32}{67.2} \]
   then \[ \frac{67.2}{1} \times \frac{5}{9} = \frac{336.0}{9} = 37.3^\circ C \]

   b. 103.4
   \[ \frac{-32}{71.4} \]
   then \[ \frac{71.4}{1} \times \frac{5}{9} = \frac{357.0}{9} = 39.7^\circ C \]

   c. 98.2
   \[ \frac{-32}{66.2} \]
   then \[ \frac{66.2}{1} \times \frac{5}{9} = \frac{331.0}{9} = 36.8^\circ C \]

   d. 102.6
   \[ \frac{-32}{70.6} \]
   then \[ \frac{70.6}{1} \times \frac{5}{9} = \frac{353.0}{9} = 39.2^\circ C \]

   e. 101.8
   \[ \frac{-32}{69.8} \]
   then \[ \frac{69.8}{1} \times \frac{5}{9} = \frac{349.0}{9} = 38.8^\circ C \]
GIVE THIS BOOKLET TO YOUR TEACHER WITH YOUR COMPLETED WORK SHEETS, AND PICK UP THE COMPLETION TEST FOR THE METRIC SYSTEM.

HAVE A HAPPY DAY!
Learning Activity Packages
Available from the Department of Education

This learning activity package is one of a series of 12 titles relating to health careers that are available from the California State Department of Education. A student packet and an instructor’s packet are published in each of the following subjects:

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