

Systems of Measurement

Course

Health Science
Technology I

Unit

Skills
Development

**Essential
Question**

What's math got
to do with it?

TEKS

121.3 1A, 1B,
1C

TAKS

ELA 1, 3
Mathematics
1,2, 3, 4, 8, 9,
10

**Prior Student
Learning**

Basic
understanding of
the metric
system and
conversions.

Estimated time

3 hours

Rationale

To pursue a career in the health care industry, the student should be proficient in academic subject content. The Health Science student will have the knowledge and skills necessary to perform the mathematical processes used in careers in health care.

Objectives

Upon completion of this lesson, the student will be able to:

- Convert units between systems of measurements;
- Use measurement functions for client assessment; and
- Interpret technical material related to health care.

Engage

Show students the sample Hematology report. Have students read the report. Ask students what does it mean? How is math used in this report?

Key Points

- I. Knowledge and skills related to mathematical conversions are important in the health care industry. **Conversion Charts**
- II. Systems of Measurement
 - A. Metric System
 - B. Apothecary System
 - C. Household System
- III. Terms used in measurement
 - A. Metric System
 - B. Scientific System
- IV. Vital Signs, I&O, and Charting
 - A. Proper technique for determining blood pressure, temperature, pulse, respirations, and I&O will be demonstrated by the teacher in another lesson.
 - B. Proper charting of client data will be demonstrated by the teacher.

Activity

- I. Analyze and interpret a sample hematology report for use of scientific notation and the metric system.
- II. Hand out conversion chart and discuss when the conversions, or formulas, might be used.
- III. Solve the **Conversion Problems**.

Assessment

Successful completion of **Conversion Problems**

Materials

Sample Hematology Report

Access to one or more of the following resources is recommended:

Simmers, Louise, *Diversified Health Occupations*, 7th edition, Delmar, 2009, ISBN 9781418030216

Kenamer, Michael, *Mathematics for Health Care Professionals*, Delmar, 2005, ISBN 9781401858032

Pickar, Gloria D., *Dosage Calculations*, Delmar, 2008, ISBN 9781418080471

Any Medical Mathematics book is helpful.

Web Sites:

www.hosa.org/natorg/sectb/cat-i/mm.pdf (HOSA Medical Math Contest with Conversion charts)

www.testandcalc.com (web site which has drug calculation problems and quizzes that either the teacher can use or students to practice)

Accommodations for Learning Differences

For reinforcement, the student will identify the difference between scientific notation and the metric system data.

For enrichment, the student will research rationale for using the metric system in health care and why it was not adopted as the universal system in the United States.

National and State Education Standards

National Health Science Cluster Standards

HLC1O.01 Technical Skills

Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

TEKS

121.3 (c) 1A convert units between systems of measurements;

121.3 (c) 1B use measurement functions for client assessment; and

121.3 (c) 1C interpret technical material related to health care.

Texas College Readiness Standards

Mathematics

IV.A. 1. Select and use the appropriate type of unit for the attribute being

measured.

- IV. B. 1. Convert from 1 measuring system to another.
- IV. B. 2. Convert within a single measurement system.

Medical Mathematics Conversion Chart HOSA Medical Mathematics Competitive Events

METRIC SYSTEM

LENGTH

10 millimeters = 1 centimeter
1 yard = 3 feet
1 foot = 12 inches

AREA

100 square millimeters = 1 square centimeter

WEIGHT

1 gram = 1000 milligrams
1 milligram = 1000 micrograms
1 gram (mass) = 1 milliliter (for solutions)
1 kilogram (mass) = 1 liter (for solutions)
1 pound = 16 ounces

TEMPERATURE

$^{\circ}\text{C} = (^{\circ}\text{F} - 32)5/9$
 $^{\circ}\text{F} = (^{\circ}\text{C})9/5 + 32$

VOLUME FOR SOLIDS

1000 cubic milliliters = 1 cubic centimeter
1000 cubic centimeters = 1 cubic decimeter
1000 cubic decimeters = 1 cubic meter
10 deciliters = 1 liter

VOLUME FOR FLUIDS

1 liter = 1000 milliliters
1 milliliter = 1 cubic centimeter
10 centiliters = 1 deciliter

APPROXIMATE EQUIVALENTS AMONG SYSTEMS

Metric

1 liter
480 – 500 milliliters
240 milliliters
30 – 42 milliliters
15 – 16 milliliters
4 – 5 milliliters/cubic centimeter
1 millimeter
1 kilogram
.045 kilogram
2.5 centimeters
4 liters

Household

1 quart / 32 ounces / 2 pints
1 pint / 16 ounces
1 cup / 8 ounces
1 ounce / 2 tablespoons / 6 teaspoons
1 tablespoon
1 teaspoon = 60 drops
60 micro drops
2.2 pounds
1 pound
1 inch
4 quarts = 1 gallon
1 glass = 8 ounces
1 teacup = 6 ounces
1 unit = 1000 milliunits
1 gtt
15 – 16 gtts

0.06 milliliters
1 milliliter

Medical Mathematics Relationships

METRIC LENGTH MEASURE

- 10 millimeters = 1 centimeter (cm)
- 10 centimeters = 1 decimeter (dm)
- 10 decimeters = 1 meter (m)
- 10 meters = 1 dekameter (dam)
- 10 dekameters = 1 hectometer (hm)
- 10 hectometer = 1 kilometer (km)

METRIC AREA MEASURE

- 100 square millimeters (mm²) = 1 square centimeter (cm²)
- 100 square centimeters (cm²) = 1 square decimeter (dm²)
- 100 square decimeters (dm²) = 1 square meter (m²)
- 100 square meters (m²) = 1 square dekameter (dam²)
- 100 square dekameter (dam²) = 1 square hectometer (hm²)
- 100 square hectometers (hm²) = 1 square kilometer (km²)

METRIC VOLUME MEASURES FOR SOLIDS

- 100 cubic millimeters (mm³) = 1 cubic centimeter (cm³)
- 100 cubic centimeters (cm³) = 1 cubic decimeter (dm³)
- 100 cubic decimeter (dm³) = 1 cubic meter (m³)
- 100 cubic meters (m³) = 1 cubic dekameter (dam³)
- 100 cubic dekameters (dam³) = 1 cubic hectometer (hm³)
- 100 cubic hectometers (hm³) = 1 cubic kilometer (km³)

METRIC VOLUME MEASURES FOR FLUIDS

- 10 milliliters (mL) = 1 centiliter (cL)
- 10 centiliters (cL) = 1 deciliter (dL)
- 10 deciliters (dL) = 1 liter (L)
- 10 liters (L) = 1 dekaliter (daL)
- 10 dekaliters (daL) = 1 hectoliter (hL)
- 10 hectoliters (hL) = 1 kiloliter (kL)

METRIC VOLUME MEASURE EQUIVALENTS

1 cubic decimeter (dm³) = 1 liter (L)
1000 cubic centimeters (cm³) = 1 liter (L)
1 cubic centimeter (cm³) = 1 milliliter (mL)

METRIC MASS MEASURE

10 milligrams (mg) = 1 centigram (cG)
10 centigrams (cG) = 1 decigram (dG)
10 decigrams (dG) = 1 gram (g)
10 grams (g) = 1 dekagram (dag)
10 dekagrams (dag) = 1 hectogram (hg)
10 hectograms (hg) = 1 kilogram (kg)
1000 kilograms (kg) = 1 megagram (Mg)

HOUSEHOLD EQUIVALENTS

APPROXIMATE LIQUID MEASURE EQUIVALENTS

60 drops = 1 teaspoonful (t)
4 teaspoonfuls = 1 tablespoonful (T)
2 tablespoonfuls = 1 fluidounce
6 fluidounces = 1 teacupful
8 fluidounces = 1 glassful

APOTHECARIES EQUIVALENTS

EQUIVALENT MEASUREMENTS OF VOLUME

60 minims (m) = 1 fluidram (f³)
8 fluidrams (f³) = 1 fluidounce
16 fluidounces = 1 pint (pt)
2 pints (pt) = 1 quart (qt)
4 quarts = 1 gallon (gal)

EQUIVALENT MEASUREMENTS OF WEIGHT

60 grains (gr) = 1 dram (ʒ)
8 drams (ʒ) = 1 ounce
12 ounces = 1 pound (lb)

DOSE AND DOSAGES

YOUNG'S RULE:

Child's Dose = (Child's Age (in years)/Child's Age in Years + 12) x Adult Dose

FRIED'S RULE:

Infant's Dose = (Age (in months) /150 pounds) x Adult Dose

CLARK'S RULE:

Child's Dose = (Weight of Child (in pounds) / 150 pounds) x Adult Dose

Child's Dose = (Weight of Child (in kilograms) / 68 kilograms) x Adult Dose

SOLUTIONS

Ratio Strength of Solutions = amount of drug / amount of solution

Percent of Strength by Volume = (volume of solute/volume of solution) x100

Percent Strength by Weight (Mass) = (mass of solute/volume of solution) x100

Amount of Solute /Amount of First Solution = Amount of Solute / Amount of Second Solution

BODY SURFACE AREA

Used to determine drug dosage in infants and children and also used to determine the loss of body fluid in ml/hour in burn patients.

Formula: BSA (m²) =0.20247 x height (m) 0.725 x weight (kg) 0.425

Web site to automatically calculate BSA:

<http://www-users.med.cornell.edu/~spon/picu/calc/bsacalc.htm>

<http://www.halls.md/body-surface-area/bsa.htm>

IV DROP RATE CALCULATION

CC'S/hour x Drop Factor of the tubing divided by 60 (minutes) = drops/minute

Calculating the Amount of Skin Burned

Overall, burn severity is a measurement of the depth of burning and the size of the burn. Measuring the size of a burn is difficult because every person is different in size, shape and weight. It's impossible to simply choose what universal size of burn is significant. A square foot of burned surface area is much worse to a person who weighs 130 pounds than it is to someone who weighs 200 pounds.

To account for inequities in size and shape, burned surface area is calculated as a percentage of total body area. Of course, we don't actually know how many square inches of skin covers any single person, but we do know about how much of our skin it takes to cover our arms and legs, for example.

The Rule of Nines

To approximate the percentage of burned surface area, the body has been divided into eleven sections:

- Head
- Right arm
- Left arm
- Chest
- Abdomen
- Upper back
- Lower back
- Right thigh
- Left thigh
- Right leg (below the knee)
- Left leg (below the knee)

Each of these sections takes about nine percent of the body's skin to cover it. Added all together, these sections account for 99 percent. The genitals make up the last one percent.

To apply the rule of nines, add up all the areas of the body that are burned deep enough to cause blisters or worse (2nd or 3rd degree burns). For example, the entire left arm and the chest covered in blisters would be 18 percent. Partial areas are approximated. For example, the face is only the front half of the head and would be considered 4.5 percent.

Since kids are shaped so much different than adults, there are adjustments made to the rule of nines, which of course ruins the point of making this tool the rule of nines. So many variations exist that it would be fruitless to go into them here.

The most important thing to remember about the rule of nines is that it is intended to be used in the field to quickly determine if victims need to go to a specialty burn center. Once the victim is in a burn center, more advanced techniques will be used to determine the exact burned surface area. (firstaid.about.com)

Conversion Problems

1. Lidocaine is available in an ampule with 100 mg in 5 ml of solution. How many ml do you give to administer 65 mg?
2. The temperature in the classroom is 86 °F. What is this in Celsius?
3. You fill a storage cabinet with 12 bottles of dextrose. Each bottle contains 15 ½ ounces. How many ounces of this solution are in the storage cabinet?
4. The physician will need a needle 7.5 cm long to take a bone marrow sample. This is equal to how many inches?
5. The stomach produces about 8 cups of gastric acid each day. How many liters is this?
6. The temperature today is –10 °F. What is the temperature in Celsius?
7. The doctor gives you a prescription for a cough medication. He tells you to take 6 mg. The label on the prescription says there are 2 mg per 4 ml. How many teaspoons do you need to take?
8. A patient drank 6 ounces of juice, 3 cups of water, and a half pint of milk. What was the total intake in ml?
9. You measure a friend who is 5 ft. 3 inches tall. What is her height in centimeters?
10. Your friend weighs 110 pounds. What is her weight in kg?
11. A laboratory technician measures 45 ml of urine sample in a 4 ounce beaker. How many more ml of urine are necessary to fill the beaker?
12. You need to find the BSA for a 10 y/o boy who is 55 inches tall and weighs 70 pounds.
13. A patient is admitted to the Emergency room with 1st degree burns over his right and left thighs, 2nd degree burns on his lower back and abdomen and 3rd degree burn over his chest. Using the rule of 9's, calculate the % of total body area burned.
14. The Doctor ordered an IV for your patient: 1000 cc of D5W over 8 hours. How many ccs will the patient receive per hour?
15. The nurse is regulating the IV according to the order. If the hospital tubing has a drop factor of 10 drops per cc, how many drops must be given per minute to deliver the number of cc's per hour in problem #14?

Answers to Conversion Problems

1. 3.25 ml
2. 30° C
3. 186 ounces
4. 3 inches
5. 1.92 Liters
6. -23.3° C
7. 2.4-3 teaspoons
8. 1140 ml
9. 157.5 cm
10. 50 kg
11. 75 ml
12. 1.12 m²
13. 27%
14. 125 cc/hour
15. 20.8=21 drops per minute

Sample Hematology Report

Anytown Lab

Patient Information
Mary Smith

Ordering Physician
Anderson, Susan

DOB: 8/26/1992

Gender: F Fasting: Y

Collected: 8/12/2006 10:15

Received: 8/12/2006 11:00

Test Name: Hematology

	In Range	Out of Range	Reference Range
White Blood Cell Count	6.1		3.8-10.8 Thous/MCL
Red Blood Cell Count	5.05		3.80-5.10 Mill/MCL
Hemoglobin		10.4 L	11.7-15.5 G/DL
Hematocrit		32 L	35.0-45.0 %
MCV	93.3		80.0-100.0 FL
MCH	32.0		27.0-33.0 PG
MCHC	34.3		32.0-36.0 G/dl
RDW	13.8		11.0-15.0 %
Platelet Count	156		140-400/Thous/MCL
Absolute Neutrophils	3245		1500-7800cells/MCL
Absolute Lymphocytes	2306		850-3900 cells/MCL
Absolute Monocytes	378		200-950 cells/MCL
Absolute Eosinophils	140		15-500 cells/MCL
Absolute Basophils	31		0-200 cells/MCL