

Healthcare Math:

Converting Measurements & Calculating Dosage per Body Weight



Industry: Healthcare

Content Area: Mathematics

Core Topics: Using the metric system, converting units of measurement using ratios and proportions and formulas, solving multi-step problems, rounding decimals

Objective: Students will be able to use proportions and formulas to convert measurements and solve multi-step problems to calculate dosage based on body weight.

Materials included:

- Instructor's notes
- Scenario: Licensed Practical Nurse (LPN)
- Student worksheets
- Handouts
- Quiz
- Answer Keys

Industry Overview:

According to the U.S. Department of Labor, the healthcare industry is expected to generate over 20% of all new jobs created in the U.S. economy between 2012 and 2022.* The healthcare industry is comprised of a vast array of jobs, ranging from nursing assistants to physicians. Mathematics and literacy skills are essential for students who plan to pursue a career in this field. The metric system is the primary measurement system used in the medical field. Healthcare professionals, including licensed practical nurses (LPNs), must have the ability to convert units of measurement between and within the US customary system and the metric system. They must also be able to solve multi-step healthcare math problems, such as calculating proper medication dosage based on patient weight.

* Source: <http://www.bls.gov/news.release/ecopro.t06.htm>

Instructor's notes:

- The purpose of this module is to help students develop and apply math skills in a healthcare workplace setting. The activities were designed to be incorporated throughout multiple instructional periods as math concepts are taught in a healthcare context.
- After completing the module, students should be able to:
 - Use ratios and proportions to convert units of measurement
 - Use formulas to convert between Fahrenheit and Celsius temperatures
 - Perform multi-step calculations to determine medication dosage based on body weight
- **Setting the stage:** Provide students with background information about the typical responsibilities of a Licensed Practical Nurse (LPN). You may want to have students use the occupational outlook handbook, O*NET and/or other relevant websites to research the job responsibilities, educational/training requirements, salary, etc. for this position. In addition, you could have students view a YouTube video depicting the typical responsibilities of a LPN (See links below).

Bureau of Labor Statistics – Occupational Outlook Handbook:

<http://www.bls.gov/ooh/>

Occupational Information Network (O*NET)

<http://www.onetonline.org/link/summary/31-9092.00>

A Day in the Life of a Licensed Practical Nurse (LPN)

<http://www.youtube.com/watch?v=Mrxz7FXcJac>

- **For Activity 1:** Provide students with examples of using the metric system and unit conversions in different healthcare contexts. As a class, work examples of converting body weight in pounds to kilograms and body height in inches to centimeters. One sample is included in the scenario. Have students complete **Worksheet 1**.
- **For Activity 2:** Explain the formulas for converting between Fahrenheit and Celsius temperatures and work examples with the students. Two sample problems have been given in the scenario, but you may want to provide additional examples. Have students work independently to convert the five medically significant Fahrenheit temperatures to Celsius. The answers are:
 $95^{\circ} F = \underline{35^{\circ} C}$ $90^{\circ} F = \underline{32.2^{\circ} C}$ $100^{\circ} F = \underline{37.8^{\circ} C}$ $102^{\circ} F = \underline{38.9^{\circ} C}$ $104^{\circ} F = \underline{40^{\circ} C}$
Have students complete **Worksheet 2**.
- **For Activity 3:** Work the scenario examples with the class. Have students work the last example independently, then go over the answers with them. The answers are: patient weight 68.2 kg minimum dose: 545.5 mg maximum dose: 682 mg range: 545.5mg to 682 mg Yes, the dose of 650 mg ordered by the doctor is safe because it falls within the acceptable range. Have students complete **Worksheet 3**.
- **Assessment: Quiz – Conversions & Calculating Dosage per Body Weight**

Workplace Scenario: Licensed Practical Nurse (LPN)

You work as a Licensed Practical Nurse (LPN) at a busy clinic. It is your responsibility to obtain the body measurements, temperature, blood pressure, and any symptoms reported by patients. You carefully record this information in each patient's chart. The doctors at the clinic rely on you to take and record accurate measurements. Precise measurements are important because many medications are prescribed based on body weight in kilograms.

Activity 1: Converting Body Measurements

Patients of all ages and sizes come into the clinic. After escorting each patient to an examination room, you measure their weight and height. The scale you use in the clinic measures weight in pounds. You record this number and then convert the person's weight into kilograms. In addition, the clinic measuring chart is in inches, so you record this number and then convert the inches into centimeters. As a student, you learned that one method of converting measurements is to use a proportion. A proportion is two equal ratios. A ratio is a fraction that makes a comparison between two numbers. For example, 2.2 pounds is equal to 1 kilogram (kg). As a ratio, this could be written as: $\frac{2.2 \text{ lbs}}{1 \text{ kg}}$. You often use a conversion chart, such as the one shown below, to help you determine the ratios you need to set up proportions for accurate measurement conversions.

Conversion Chart

1000 g = 1 kg	1000 mg = 1 g
1000 mcg = 1 mg	1 ml = 1 cc
5 ml = 1 tsp. (t.)	15 ml = 1 tbsp. (T.)
30 ml = 1 oz.	2.2 lb = 1 kg
2.5 cm = 1 inch	1000 ml = 1 L

Look at the following examples. A 15 year old patient comes into the clinic. You weigh her on the clinic scale and find that she weighs 120 pounds. You then set up a proportion to convert her weight in pounds to body mass in kilograms. Since you know 2.2 lbs. is equal to 1 kilogram, this would be your first ratio, $\frac{2.2 \text{ lb}}{1 \text{ kg}}$. Your second ratio would be $\frac{120 \text{ lb}}{x \text{ kg}}$; the x denotes the unknown number of kilograms that is equal to 120 pounds. To solve the proportion, you cross multiply the numbers in the proportion to get an equation of $2.2x = 120$. Next, you solve for x by dividing both sides of the equation by 2.2. The answer is: 120 lb = 54.5 kg. See the steps below.

$$\frac{2.2 \text{ lb}}{1 \text{ kg}} = \frac{120 \text{ lb}}{x \text{ kg}} \quad \longrightarrow \quad 2.2x = 120 \quad \longrightarrow \quad x = 120 \div 2.2 \quad \longrightarrow \quad x = \underline{54.5 \text{ kg}}$$

After measuring the patient, you find that she is 63 inches tall. You then need to convert her height in inches to centimeters. Using the conversion chart above, you know that one inch is equal to 2.5 centimeters (cm). You set up the following proportion to convert the patient's height in inches to height in centimeters.

$$\frac{1 \text{ in}}{2.5 \text{ cm}} = \frac{63 \text{ in}}{x \text{ cm}} \quad \longrightarrow \quad (1)x = 63(2.5) \quad \longrightarrow \quad x = \underline{157.5 \text{ cm}}$$

Important: To avoid errors, always include the unit of measurement in your proportion and answer.

Worksheet 1: Converting Body Measurements

Name _____

On Tuesday morning, the clinic is very busy. You weigh and measure every patient that comes in for care. After recording these numbers on each patient's chart, you use a proportion to convert their weight in pounds into kilograms (kg) and their height in inches into centimeters (cm). Round your answer to the nearest tenths place, if necessary. Complete the chart for each patient.

Patient name	Weight in lbs.	Weight in kg	Height in inches	Height in cm
J. James	15 lb.		24 in.	
F. Garza	180 lb.		70 in.	
J. Hamilton	135 lb.		61 in.	
R. Hargrave	52 lb.		46 in.	
M. Sherman	196 lb.		69 in.	
D. Hagopian	238 lb.		73 in.	
L. Wolf	78 lb.		55 in.	
V. Graham	162 lb.		60 in.	
D. Mendez	140 lb.		67 in.	
R. Smith	38 lb.		39 in.	
M. Abdul	172 lb.		57 in.	
P. Baker	128 lb.		65 in.	

Activity 2: Converting Fahrenheit and Celsius Temperature

In addition to measuring weight and height, you also take and record each patient's temperature. You usually use a Fahrenheit thermometer, but the clinic recently purchased a Celsius thermometer. While the doctors prefer the Celsius reading, most patients are more familiar with the Fahrenheit temperature reading. Regardless of which thermometer you use, the doctors at the clinic have instructed you to always record both readings on the patient's chart.

The formula for converting from Fahrenheit (F) to Celsius (C) is: $(^{\circ}\text{F} - 32) \div 1.8 = ^{\circ}\text{C}$

The formula for converting from Celsius (C) to Fahrenheit (F) is: $(^{\circ}\text{C} \times 1.8) + 32 = ^{\circ}\text{F}$

Practice converting the following temperatures:

The weather forecast for today is 84°F . Use the appropriate formula and convert this temperature to Celsius. Write the formula and substitute 84 for the F. Subtract 32 from 84. Divide the result by 1.8 and round to the nearest tenths place. Your answer should be 28.9.

$$C = (F - 32) \div 1.8 \longrightarrow C = (84 - 32) \div 1.8 \longrightarrow C = 52 \div 1.8 \longrightarrow 84^{\circ}\text{F} = \underline{28.9^{\circ}\text{C}}$$

Imagine that you are on vacation in France and the forecast for today is 30°C . Convert this temperature to Fahrenheit. Write the formula and substitute 30 for C. Next, multiply 30×1.8 . The result is 54. Add $54 + 32$. Your answer should be 86.

$$F = (C \times 1.8) + 32 \longrightarrow F = (30 \times 1.8) + 32 \longrightarrow F = 54 + 32 \longrightarrow 30^{\circ}\text{C} = \underline{86^{\circ}\text{F}}$$

Since you have worked at the clinic for a few years, you know the following temperatures have important medical significance. Use the appropriate conversion formula and convert each Fahrenheit temperature to Celsius.

Mild Hypothermia: $95^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$

Moderate to severe hypothermia: $90^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$

Mild Fever: $100^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$

Moderate Fever: $102^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$

Severe Fever: $104^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$

Worksheet 2: Converting Temperature Readings

Name _____

You took the temperature of each patient who came into the clinic on Tuesday morning. Depending on which thermometer you used, some of the patients' temperatures were taken in Fahrenheit degrees, and others in Celsius degrees. For each given temperature reading on the chart, use the appropriate formula to convert to the other system. Round your answer to the nearest tenths place, if necessary.

Patient name	Fahrenheit temperature reading	Celsius temperature reading
J. James	101 ⁰ F	
F. Garza		37 ⁰ C
J. Hamilton	98.8 ⁰ F	
R. Hargrave	98.6 ⁰ F	
M. Sherman	99.3 ⁰ F	
D. Hagopian		38.5 ⁰ C
L. Wolf		39 ⁰ C
V. Graham	99 ⁰ F	
D. Mendez		37.3 ⁰ C
R. Smith	101.5 ⁰ F	
M. Abdul	98.5 ⁰ F	
P. Baker		36.7 ⁰ C

After completing the chart, answer the following questions.

1. According to your calculations, how many patients have a fever?
2. Which patient has the highest temperature?
3. What is the temperature in Celsius for this patient?
4. What is the medically significant classification of this temperature?

Activity 3: Calculating dosage based on patient weight

Another job you have at the clinic is to calculate the correct dosage of medication and shots for patients. Many medications have a recommended dosage based on body weight. For example, suppose the recommended dose of a medicine is 5 milligrams per kilogram of body weight (5mg/kg). What is the correct dose for a person weighing 120 kilograms? One method to calculate the dosage per kilogram is to use a proportion.

$$\frac{5 \text{ mg}}{1 \text{ kg}} = \frac{X \text{ mg}}{120 \text{ kg}} \quad \text{Cross multiply: } (1)x = (5)120 \quad \text{Multiply to solve for x: } x = \underline{600 \text{ mg.}}$$

Some dosage calculations require multiple steps. The doctor ordered 20 mg/kg of medication divided into 2 equal doses for a child who weighs 60 lb. What is the correct amount of medication you will give this child in each dose? Remember, when you calculate weight conversions or dosage using a proportion, the units of measurement must be the same. Use labels to avoid errors.

Step1: Convert the child's weight to kilograms (kg).

$$\frac{2.2 \text{ lb}}{1 \text{ kg}} = \frac{60 \text{ lb}}{X \text{ kg}} \quad 2.2x = 60 \quad x = 60 \div 2.2 \quad \text{Divide to solve for x: } x = \underline{27.3\text{kg.}}$$

Step 2: Calculate the total dosage for this child: $\frac{20 \text{ mg}}{1 \text{ kg}} = \frac{X \text{ mg}}{27.3 \text{ kg}}$. The total dosage is 546 mg.

Step 3: Since the doctor ordered the total amount of medication to be given in 2 equal doses. The last step would be to divide the total dose by 2. $546 \div 2 = 273$ Each dose will be 273 mg.

Work the following example. Round your answers to the nearest tenths place, if necessary.

At times, you have to calculate the dosage range of a medication based on patient weight in order to determine if the dose prescribed is safe. One of the clinic doctors ordered 650 mg of medicine for a patient weighing 150 lb. The recommended dosage for the medication is 8 -10 mg/kg of body weight. Is the dosage ordered by the doctor safe for this patient?

Convert the patient's weight to kilograms. The patient weighs _____ kg.

Calculate the minimum dosage for this patient (8mg/kg). The minimum dosage recommended for this patient is _____ mg.

Calculate the maximum dosage for this patient (10mg/kg). The maximum dosage allowed for this patient is _____ mg.

The dosage range for this drug is _____ to _____ mg. If the dose ordered by the doctor falls within this range, it is safe for the patient.

Worksheet 3: Calculating dosage based on patient weight Name _____

Tuesday is a busy day at the clinic. Several patients need medications or shots. You will have to calculate the dosage of medicine based on body weight for some of these patients. Round your answers to the nearest tenths place, if necessary.

M. Garcia is to be given medication with a recommended dose of 4 mg/kg of body weight. She weighs 64 kg.

How much medicine will you give Ms. Garcia? _____

J. Smith weighs 205 lb. The doctor orders 15 mg/kg of medication.

Convert the patient's weight into kilograms. Mr. Smith weighs _____ kg.

What is the correct dose of medication for Mr. Smith? _____ mg.

The doctor orders a shot of 0.1 cc/kg medication for a 40 lb. child.

Convert the child's weight into kilograms. The child weighs _____ kg.

The correct dose for this child's shot is _____ cc.

The doctor orders 1500 mg of medication for D. Cameron who weighs 185 lb. The label on the medication states the recommended dosage for the medication is 15-25 mg/kg of body weight. Is the dose prescribed by the doctor safe for this patient?

Convert the patient's weight into kilograms. The patient weighs _____ kg.

Calculate the dosage range: Minimum dose _____ to _____ Maximum dose

Is the dose prescribed safe for this patient? Yes or No

The doctor prescribed 50 mg/kg divided into 3 equal doses for a toddler who weighs 25 lbs.

The toddler weighs _____ kg.

The total dosage to be given is _____ mg.

Each individual dose will be _____ mg.

Quiz: Measurement Conversions & Dosage per Body Weight Name: _____

Convert each of the following weights into kilograms (kg) and heights into centimeters (cm)

1. 55 lb. = _____ kg
2. 100 lb. = _____ kg
3. 155 lb. = _____ kg
4. 270 lb. = _____ kg
5. 22 lb. = _____ kg
6. 45 inches = _____ cm
7. 58 inches = _____ cm
8. 66 inches = _____ cm
9. 75 inches = _____ cm
10. 28 inches = _____ cm

Convert each of the temperatures to Fahrenheit or Celsius as indicated.

11. An infant has a body temperature of 96.5⁰F _____ ⁰C
12. Store the vaccine serum at 8⁰C _____ ⁰F
13. Do not expose the medication to temperatures greater than 75⁰F _____ ⁰C
14. Mr. Doe's temperature is greater than 103⁰F _____ ⁰C

Convert each patient's weight to kilograms (kg) and calculate the medication dosage

15. Dr. Patel orders 40 mg/kg of medication for a patient weighing 150 lb.
Patient weighs _____ kg Dosage: _____ mg
16. A patient weighing 300 lb. is prescribed medication of 25 mg/kg of body weight.
Patient weighs _____ kg Dosage: _____ mg
17. Dr. Jones orders 5mg/kg of medication for a patient weighing 75 lb.
Patient weighs _____ kg Dosage: _____ mg
18. A doctor orders 2500 mg of medication for a patient weighing 125 lb. The recommended dosage for this drug is 30-40 mg/kg. Determine if the dosage is safe for this patient.
Patient weighs _____ kg Dosage range: Minimum _____ to _____ Maximum _____
Is the dosage ordered safe for this patient? Yes or No

Worksheet 1: Converting Body Measurements**Answer Key**

On Tuesday morning, the clinic is very busy. You weight and measure every patient that comes in for care. After recording these numbers on each patient's chart, you use a proportion to convert their weight in pounds into kilograms (kg) and their height in inches into centimeters (cm). Round your answer to the nearest tenths place, if necessary.

Patient name	Weight in lbs.	Weight in kg	Height in inches	Height in cm
J. James	15 lb.	6.8 kg	24 in.	60 cm
F. Garza	180 lb.	81.8 kg	70 in.	175 cm
J. Hamilton	135 lb.	61.4 kg	61 in.	152.5 cm
R. Hargrave	52 lb.	23.6 kg	46 in.	115 cm
M. Sherman	196 lb.	89.1 kg	69 in.	172.5 cm
D. Hagopian	238 lb.	108.2 kg	73 in.	182.5 cm
L. Wolf	78 lb.	35.5 kg	55 in.	137.5 cm
V. Graham	162 lb.	73.6 kg	60 in.	150 cm
D. Mendez	140 lb.	63.6 kg	67 in.	167.5 cm
R. Smith	38 lb.	17.3 kg	39 in.	97.5 cm
M. Abdul	172 lb.	78.2 kg	57 in.	142.5 cm
P. Baker	128 lb.	58.2 kg	65 in.	162.5 cm

Worksheet 2: Converting Temperature Readings**Answer Key**

You took the temperature of each patient who came into the clinic on Tuesday morning. Depending on which thermometer you used, some of the patients' temperatures were taken in Fahrenheit degrees, and others in Celsius degrees. For each given temperature reading, use the appropriate formula to convert to the other system. Round your answer to the nearest tenths place, if necessary.

Patient name	Fahrenheit temperature reading	Celsius temperature reading
J. James	101 ⁰ F	38.3 ⁰ C
F. Garza	98.6 ⁰ F	37 ⁰ C
J. Hamilton	98.8 ⁰ F	37.1 ⁰ C
R. Hargrave	98.6 ⁰ F	37 ⁰ F
M. Sherman	99.3 ⁰ F	37.4 ⁰ F
D. Hagopian	101.3 ⁰ F	38.5 ⁰ C
L. Wolf	102.2 ⁰ F	39 ⁰ C
V. Graham	99 ⁰ F	37.2 ⁰ C
D. Mendez	99.1 ⁰ F	37.3 ⁰ C
R. Smith	101.5 ⁰ F	38.6 ⁰ C
M. Abdul	98.5 ⁰ F	36.9 ⁰ C
P. Baker	98.1 ⁰ F	36.7 ⁰ C

After completing the chart, answer the following questions.

1. According to your calculations, how many patients have a fever? **4**
2. Which patient has the highest temperature? **L. Wolf**
3. What is the temperature in Celsius for this patient? **39⁰ C**
4. What is the medically significant classification of this temperature? **Moderate fever**

Worksheet 3: Calculating dosage based on patient weight

Answer Key

Tuesday is a busy day at the clinic. Several patients need medications or shots. You will have to calculate the dosage of medicine based on body weight for some of these patients. Round your answers to the nearest tenths place, if necessary.

M. Garcia is to be given medication with a recommended dose of 4 mg/kg of body weight. She weighs 64 kg.

How much medicine will you give Ms. Garcia? 256 mg

J. Smith weighs 205 lb. The doctor orders 15 mg/kg of medication.

Convert the patient's weight into kilograms. Mr. Smith weighs 93.2 kg.

What is the correct dose of medication for Mr. Smith? 1398 mg.

The doctor orders a shot of 0.1 cc/kg medication for a 40 lb. child.

Convert the child's weight into kilograms. The child weighs 18.2 kg.

The correct dose for this child's shot is 1.8 cc.

The doctor orders 1500 mg of medication for D. Cameron who weighs 185 lb. The label on the medication states the recommended dosage for the medication is 15-25 mg/kg of body weight. Is the dose prescribed by the doctor safe for this patient?

Convert the patient's weight into kilograms. The patient weighs 84.1 kg.

Calculate the dosage range: Minimum dose 1261.5 kg to 2102.5 kg Maximum dose

Is the dose prescribed safe for this patient? Yes

The doctor prescribed 50 mg/kg divided into 3 equal doses for a toddler who weighs 25 lb.

The toddler weighs 11.4 kg.

The total dosage to be given is 570 mg.

Each individual dose will be 190 mg.

Quiz: Measurement Conversions & Dosage per Body Weight**Answer Key**

Convert each of the following weights into kilograms (kg) and heights into centimeters (cm)

1. 55 lb = 25 kg
2. 100 lb = 45.5 kg
3. 155 lb = 70.5 kg
4. 270 lb = 122.7 kg
5. 22 lb = 10 kg
6. 45 inches = 112.5 cm
7. 58 inches = 145 cm
8. 66 inches = 165 cm
9. 75 inches = 187.5 cm
10. 28 inches = 70 cm

Convert each of the temperatures to Fahrenheit or Celsius as indicated.

11. An infant has a body temperature of 96.5⁰F 35.8⁰C
12. Store the vaccine serum at 8⁰C 46.4⁰F
13. Do not expose the medication to temperatures greater than 75⁰F 23.9⁰C
14. Mr. Doe's temperature is greater than 103⁰F 39.4⁰C

Convert each patient's weight to kilograms (kg) and calculate the medication dosage as directed.

15. Dr. Patel orders 40 mg/kg of medication for a patient weighing 150 lb.
Patient weighs 68.2 kg Dosage: 2728 mg
16. A patient weighing 300 lb. is prescribed medication of 25 mg/kg of body weight.
Patient weighs 136.4 kg Dosage: 3410 mg
17. Dr. Jones orders 5mg/kg of medication for a patient weighing 75 lb.
Patient weighs 34.1 kg Dosage: 170.5 mg
18. A doctor orders 2500 mg of medication for a patient weighing 125 lb. The recommended dosage for this drug is 30-40 mg/kg. Determine if the dosage is safe for this patient.
Patient weighs 56.8 kg Dosage range: Minimum 1704 mg to 2272 mg Maximum
Is the dosage ordered safe for this patient? No (2500 mg exceeds the maximum dose allowed)