

Module 4: Conversion Calculations and Dosage Calculations

4.1 Conversions with Lengths, Weight (Mass), and Volume

1. Learn How to Perform Conversions using One Conversion Factor

A **conversion factor** is a *fraction* or *ratio* involving two equivalent quantities that are expressed in different units. For example, if you wish to convert inches to centimeters, you will need to use a conversion factor to perform the calculation. Recall that $2.54 \text{ cm} = 1 \text{ in.}$

This gives us the conversion factor $\left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right)$ which is equivalent to $\left(\frac{1 \text{ in.}}{2.54 \text{ cm}}\right)$. Next, we will need to develop a sense of how to choose the appropriate conversion factor or factors, for a given conversion calculation.

Example 1: How many centimeters are in 10 inches?

In this example we are being asked to convert 10 in. to cm. We begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{10 \text{ in.}}{1}\right)$$

Next, we will multiply our given quantity using the appropriate conversion factor to get the desired result in centimeters.

$$\underbrace{\left(\frac{10 \text{ in.}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right)}_{\text{Conversion Factor}}$$

Notice that the denominator of our conversion factor contains units of inches. This allows us to divide out the units of inches leaving the desired units of centimeters. Here is what our completed conversion calculation will look like.

$$\left(\frac{10 \cancel{\text{ in.}}}{1}\right) \left(\frac{2.54 \text{ cm}}{1 \cancel{\text{ in.}}}\right) = 25.4 \text{ cm}$$

Based on our conversion calculation, we can now answer the question by stating there are 25.4 centimeters in 10 inches.

When performing conversion calculations it is always important to show how you reached your solution. This will allow someone else to easily verify that your calculation is correct by checking your work.

Note: In Example 1 above, the conversion factor was written for converting inches to centimeters. In the next example we will convert from centimeters to inches. Notice how the conversion factor differs in Example 2.

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Example 2: How many inches are in 35 centimeters?

In this example we are being asked to convert 35 cm to inches. Again, we begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{35 \text{ cm}}{1}\right)$$

Next, we will multiply our given quantity using the appropriate conversion factor to get the desired result in inches.

$$\underbrace{\left(\frac{35 \text{ cm}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ in.}}{2.54 \text{ cm}}\right)}_{\text{Conversion Factor}}$$

In this example, notice that the denominator of our conversion factor contains units of centimeters. This allows us to divide out the units of centimeters leaving the desired units of inches. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{35 \cancel{\text{ cm}}}{1}\right) \left(\frac{1 \text{ in.}}{2.54 \cancel{\text{ cm}}}\right) = 13.780 \text{ in.}$$

Based on our conversion calculation, we can now answer the question by stating there are approximately 13.780 inches in 35 centimeters.

Perform the following conversion calculations using one conversion factor.

- 1) How many seconds are in 17 minutes?
- 2) How many feet are in 40 yards?
- 3) Convert 10 cm to inches.
- 4) Convert 25 inches to centimeters.
- 5) Convert 2 liters to quarts.
- 6) Convert 5,000 pounds to tons.
- 7) If one tablet contains 150 mg of ibuprofen, how much ibuprofen is in $3\frac{1}{2}$ tablets?
- 8) Given that 1 kilogram = 2.2 pounds, how many kilograms does a 175 lb adult male weigh?

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2. Learn How to Perform Conversions using Multiple Conversion Factors

Many conversion calculations require the use of more than one conversion factor to obtain the desired result. In these cases, we let the dimensions guide us through the calculations, telling us where to put the numeric values. This approach will be demonstrated in Example 3 and Example 4. We will be using the following equivalent relationships to perform these types of conversion calculations.

$$12 \text{ in.} = 1 \text{ ft} \quad 3 \text{ ft} = 1 \text{ yd} \quad 5,280 \text{ ft} = 1 \text{ mile} \quad 2.54 \text{ cm} = 1 \text{ in.}$$

Other equivalent relationships can be found on the conversion handout sheet found at the end of this sections material.

Example 3: How many miles are in 500,000 inches?

As always, we begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{500,000 \text{ in.}}{1} \right)$$

Our first conversion factor will convert inches to feet by placing units of inches in the denominator and feet in the numerator.

$$\underbrace{\left(\frac{500,000 \text{ in.}}{1} \right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ ft}}{12 \text{ in.}} \right)}_{\text{Conversion Factor}}$$

Our second conversion factor will now convert feet to miles by placing feet in the denominator and miles in the numerator.

$$\underbrace{\left(\frac{500,000 \text{ in.}}{1} \right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ ft}}{12 \text{ in.}} \right)}_{\text{Conversion Factor}} \underbrace{\left(\frac{1 \text{ mi}}{5,280 \text{ ft}} \right)}_{\text{Conversion Factor}}$$

Notice that the denominators of our conversion factors divide out the units in the preceding numerators. This leaves us with the desired units of miles. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{500,000 \cancel{\text{ in.}}}{1} \right) \left(\frac{1 \cancel{\text{ ft}}}{12 \cancel{\text{ in.}}} \right) \left(\frac{1 \text{ mi}}{5,280 \cancel{\text{ ft}}} \right) = 7.891 \text{ mi}$$

Based on our conversion calculation, we can now answer the question by stating there are approximately 7.891 miles in 500,000 inches.

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Example 4: How many yards are in 4,500 centimeters?

Again, we first write the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{4,500 \text{ cm}}{1}\right)$$

Our first conversion factor will convert centimeters to inches by placing units of centimeters in the denominator and inches in the numerator.

$$\underbrace{\left(\frac{4,500 \text{ cm}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ in.}}{2.54 \text{ cm}}\right)}_{\text{Conversion Factor}}$$

Our second conversion factor will now convert inches to feet by placing inches in the denominator and feet in the numerator.

$$\underbrace{\left(\frac{4,500 \text{ cm}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ in.}}{2.54 \text{ cm}}\right)}_{\text{Conversion Factor}} \underbrace{\left(\frac{1 \text{ ft.}}{12 \text{ in.}}\right)}_{\text{Conversion Factor}}$$

Our third conversion factor will now convert feet to yards by placing feet in the denominator and yards in the numerator.

$$\underbrace{\left(\frac{4,500 \text{ cm}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ in.}}{2.54 \text{ cm}}\right)}_{\text{Conversion Factor}} \underbrace{\left(\frac{1 \text{ ft.}}{12 \text{ in.}}\right)}_{\text{Conversion Factor}} \underbrace{\left(\frac{1 \text{ yd}}{3 \text{ ft.}}\right)}_{\text{Conversion Factor}}$$

Again we see that the denominators of our conversion factors divide out the units in the preceding numerators. Doing so leaves us with the desired units of yards. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{4,500 \cancel{\text{ cm}}}{1}\right) \left(\frac{1 \cancel{\text{ in.}}}{2.54 \cancel{\text{ cm}}}\right) \left(\frac{1 \cancel{\text{ ft.}}}{12 \cancel{\text{ in.}}}\right) \left(\frac{1 \text{ yd}}{3 \cancel{\text{ ft.}}}\right) = 49.213 \text{ yd}$$

Based on our conversion calculation, we can now answer the question by stating there are approximately 49.213 yards in 4,500 centimeters.

Perform the following conversion calculations using multiple conversion factors.

9) How many meters are in 1 mile?

11) Convert 3 pounds to grams.

10) How many seconds are in 1 year?

12) Convert 2 liters to ounces.

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3. Solve Applied Problems using Conversion Calculations

Conversion calculations can be used to solve many of the applied problems seen within the Health Care career field. Probably the most important types of conversion calculations are applied problems that involve dosage calculations. With these types of problems, a given *solution strength ratio* or *dosage strength ratio* is used as a conversion factor. The following examples represent common dosage calculations using this approach.

Example 5: Suppose you found that 100 mL of a solution contains 1 gram of lidocaine. How many mg of lidocaine are in $2\frac{1}{2}$ mL of the solution?

We begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{2.5 \text{ mL}}{1}\right)$$

Next, we multiply our given quantity by the solution strength ratio. This conversion factor will convert milliliters to grams by placing units of milliliters in the denominator and grams in the numerator. This allows us to divide out the units of mL leaving us with grams of lidocaine.

$$\underbrace{\left(\frac{2.5 \text{ mL}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ g}}{100 \text{ mL}}\right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(Solution Strength)}}}$$

Now we must convert the grams of lidocaine to mg. To accomplish this, we add a second conversion factor that will convert grams to milligrams.

$$\underbrace{\left(\frac{2.5 \text{ mL}}{1}\right)}_{\text{Given Quantity}} \underbrace{\left(\frac{1 \text{ g}}{100 \text{ mL}}\right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(Solution Strength)}}} \underbrace{\left(\frac{1,000 \text{ mg}}{1 \text{ g}}\right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(grams to milligrams)}}$$

Once again the denominators of our conversion factors divide out the units in the preceding numerators. Doing so leaves us with the desired units of milligrams of lidocaine. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{2.5 \cancel{\text{ mL}}}{1}\right) \left(\frac{1 \cancel{\text{ g}}}{100 \cancel{\text{ mL}}}\right) \left(\frac{1,000 \text{ mg}}{1 \cancel{\text{ g}}}\right) = 25.000 \text{ mg of lidocaine}$$

Based on our conversion calculation, we can now answer the question by stating there are 25.000 mg of lidocaine in 2.5 mL of solution.

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Example 6: Suppose you found that 1,000 mL of a solution contains 1 g of epinephrine. How many mg of epinephrine are in 2 tbsp of solution? Assume 1 tbsp = 15 mL.

Notice that we are given a volume measured by tablespoons. Because our solution strength ratio involves volume by milliliters, we must begin our conversion calculation by first converting tablespoons to milliliters.

We start by first representing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{2 \text{ tbsp}}{1} \right)$$

Our first conversion factor will convert tablespoons to milliliters. Notice that by placing units of tablespoons in the denominator and milliliters in the numerator, we can divide out the units of tablespoons leaving us with milliliters of epinephrine.

$$\underbrace{\left(\frac{2 \text{ tbsp}}{1} \right)}_{\text{Given Quantity}} \underbrace{\left(\frac{15 \text{ mL}}{1 \text{ tbsp}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(tbsp to mL)}}$$

Next, we use our solution strength ratio as the second conversion factor to convert milliliters to grams. Notice that milliliters are placed in the denominator and grams in the numerator. This allows us to divide out the units of milliliters leaving us with grams of epinephrine. At this point, the calculation will give us the grams of epinephrine in 2 tbsp of solution.

$$\underbrace{\left(\frac{2 \text{ tbsp}}{1} \right)}_{\text{Given Quantity}} \underbrace{\left(\frac{15 \text{ mL}}{1 \text{ tbsp}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(tbsp to mL)}}} \underbrace{\left(\frac{1 \text{ g}}{1,000 \text{ mL}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(Solution Strength)}}$$

Because we are asked to calculate the dosage of epinephrine in mg, we need to add an additional conversion factor that will convert grams to milligrams. Doing this leaves us with the desired units of milligrams of epinephrine.

$$\underbrace{\left(\frac{2 \text{ tbsp}}{1} \right)}_{\text{Given Quantity}} \underbrace{\left(\frac{15 \text{ mL}}{1 \text{ tbsp}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(tbsp to mL)}}} \underbrace{\left(\frac{1 \text{ g}}{1,000 \text{ mL}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(Solution Strength)}}} \underbrace{\left(\frac{1,000 \text{ mg}}{1 \text{ g}} \right)}_{\substack{\text{Conversion} \\ \text{Factor} \\ \text{(grams to milligrams)}}$$

Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{2 \cancel{\text{tbsp}}}{1} \right) \left(\frac{15 \cancel{\text{mL}}}{1 \cancel{\text{tbsp}}} \right) \left(\frac{1 \cancel{\text{g}}}{1,000 \cancel{\text{mL}}} \right) \left(\frac{1,000 \text{ mg}}{1 \cancel{\text{g}}} \right) = 30.000 \text{ mg epinephrine}$$

Based on our conversion calculation, we can now answer the question by stating there are approximately 30.000 mg of epinephrine in 2 tbsp of solution.

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Solve the applied problems.

13) The solution strength label of a solution indicates that 100 mL contains 10 grams of magnesium sulfate. How many mL of solution will contain 350 mg of magnesium sulfate?

14) The solution strength label of a solution indicates that 2,000 mL contains 1 gram of epinephrine. How many mL of solution will contain 0.25 mg of epinephrine?

15) Suppose you found that 5 mL of a solution contains 0.25 grams of Amoxicillin. How many mg of Amoxicillin are in 2 tbsp of solution? Assume 1 tbsp = 15 mL.

16) Suppose you found that 5 mL of a solution contains 0.1 grams of Motrin[®]. How many mg of Motrin[®] are in 2 tsp of solution? Assume 1 tsp = 5 mL.

Review Exercises

Evaluate the expression.

$$17) \frac{3}{4} \cdot \frac{6}{7} \cdot \frac{10}{4}$$

$$18) 3 + \frac{6}{5} \div \frac{3}{20}$$

Simplify the expression as much as possible.

$$19) \frac{4y^3}{x^2} \cdot \frac{x}{3} \div \frac{y}{4}$$

$$20) \frac{5a^3}{b^{-2}} \div \frac{15b^3}{7} \cdot \frac{a^{-1}b}{21}$$

Fill in the blank with the appropriate metric unit.

21) The width of a dollar bill is approximately 6.6 ____.

22) The diameter of a quarter is approximately 24 ____.

Fill in the blanks with the appropriate metric prefix.

23) ____ means $\frac{1}{1,000}$.

24) ____ means $\frac{1}{100}$.

Equivalent Measurement Table

12 inches = 1 foot	1 pound = 16 ounces
3 feet = 1 yard	1 Ton = 2,000 pounds
5,280 feet = 1 mile	28.3 grams \approx 1 ounce
2.54 centimeter = 1 inch	2.20 pounds \approx 1 kilogram
1 cup = 8 fluid ounces	16.39 milliliter = 1 in ³
2 cups = 1 pint	1 milliliter = 1 cc (1 cm ³)
2 pints = 1 quart	1 teaspoon \approx 5 milliliters
4 quarts = 1 gallon	1 tablespoon \approx 15 milliliters
	1 fluid ounce \approx 29.6 milliliters
1,000 mL = 1 L	$C^{\circ} = \frac{5(F^{\circ} - 32)}{9}$
1,000,000 μ L = 1 L	$F^{\circ} = \frac{9}{5}C^{\circ} + 32$
1.06 quarts \approx 1 L	
1 gallon \approx 3.79 L	