Metric Conversions & Defining Appropriate Units

The Metric System of Measurement is based on multiples of 10. The three base units are meters, liters, and grams. The 6 prefixes are kilo (1000), hector (100), deka (10), base unit (1), deci (.1), centi (.01), and milli (.001). A helpful way to remember the order of the prefixes is **King Henry Died Unusually Drinking Chocolate Milk**.

Metric Conversion

King	Henry	Died	Unusually	Drinking	Chocolate	Milk
Kilo	Hecto	Deca	* Unit *	Deci	Centi	Milli
10 x 10 x 10 x LARGER than a unit	**10 x 10 x LARGER than a unit**	**10 x LARGER than a unit**	***Meter*** *(length)* ***Liter*** *(liquid volume)* ***Gram*** *(mass/weight)*	**10 x SMALLER than a unit**	**10 x 10 x SMALLER than a unit**	**10 x 10 x 10 x SMALLER than a unit**
1 kilo = 1,000 units	1 hecto = 100 units	1 deca = 10 units	**1 unit**	10 deci = 1 unit	100 centi = 1 unit	1,000 milli = 1 unit
km = kilometer kL = kiloliter kg = kilogram	hm = hectometer hL = hectoliter hg = hectogram	dam = decameter daL = decaliter dag = decagram	m = meter L = liter g = gram	dm = decimeter dL = deciliter dg = decigram	cm = centimeter cL = centiliter cg = centigram	mm = millimeter mL = milliliter mg = milligram
Example: 5 kilo	50 hecto	500 deca	5,000 units	50,000 deci	500,000 centi	5,000,000 milli

DIVIDE numbers by 10 if you are getting bigger (same as moving decimal point one space to the left)

MULTIPLY numbers by 10 if you are getting smaller (same as moving decimal point one space to the right)

Examples: Convert from one prefix to another

A. 2500 L = _____ kL

B. 38.2 g = _____ cg

C. 5 m = _____ mm

D. 1000 mg = _____ g

E. 14 km = _____ m

F. 1 L = _____ mL

Examples: Compare measurements using <, >, or =.
(Hint: They have to be written in the same units of measure before you can compare.)

A. 502 mm _____ .502 m

B. 90,801 cg _____ 5 g

C. 160 cL _____ 1.6 L

Dimensional Analysis

There are many different units of measure specific to the U.S. Customary System that you will need to remember. The list below summarizes some of the most important.

Measurement	Time	Capacity	Weight
1 foot = _____ inches	1 minute = _____ seconds	1 cup = _____ fl. oz	1 ton = _____ lbs
1 yard = _____ feet	1 hour = _____ minutes	1 pint = _____ cups	1 lb = _____ oz
1 mile = _____ feet	1 day = _____ hours	1 quart = _____ pints	
1 mile = _____ yards	1 week = _____ days	1 gal = _____ quarts	
	1 year = _____ weeks		

In order to convert between units, you must use a conversion factor. A **conversion factor** is a fraction in which the numerator and denominator represent the same quantity, but in different units of measure.

Examples: 3 feet = 1 yard: $\frac{3\text{ feet}}{1\text{yard}}$ OR $\frac{1\text{yard}}{3\text{ feet}}$

100 centimeters = 1 meter: $\frac{100\text{ cm}}{1\text{m}}$ OR $\frac{1\text{m}}{100\text{ cm}}$

Multiplying a quantity by a unit conversion factor changes only its units, not its value. It is the same thing as multiplying by 1.

$$\frac{100\text{ cm}}{1\text{m}} = \frac{100\text{ cm}}{100\text{ cm}} = 1$$

The process of choosing an appropriate conversion factor is called **dimensional analysis.**

Understanding Dimensional Analysis

When setting up your conversion factors, don't worry about the actual numbers until the very end. The key to set up your conversion factors so that they cancel out the units you don't want until you end up with the units that you do want.

1. Convert 5 miles to inches.

Possible Conversion Factors: $\frac{\text{yards}}{\text{miles}}$ **or** $\frac{\text{miles}}{\text{yard}}$ $\frac{\text{Inches}}{\text{feet}}$ **or** $\frac{\text{feet}}{\text{inches}}$ $\frac{\text{yard}}{\text{feet}}$ **or** $\frac{\text{feet}}{\text{yards}}$

2. Convert from 94 cups to gallons.

Possible Conversion Factors: $\frac{\text{cups}}{\text{pints}}$ **or** $\frac{\text{pints}}{\text{cups}}$ $\frac{\text{quarts}}{\text{pints}}$ **or** $\frac{\text{pints}}{\text{quarts}}$ $\frac{\text{gallons}}{\text{quarts}}$ **or** $\frac{\text{quarts}}{\text{gallons}}$

Practicing Dimensional Analysis

Scenario: How many feet are in 72 inches?

Step 1: Write the given quantity with its unit of measure.	
Step 2: Set up a conversion factor. (Choose the conversion factor that cancels the units you have and replaced them with the units you want. $\frac{\text{what you want}}{\text{what you have}}$	
Step 3. Divide the units (only the desired unit should be left).	
Step 4: Solve the problem using multiplication and/or division.	

Scenario 1: How many cups are in 140 pints? (2 cups = 1 pint)

Scenario 2: How many feet are in 4.5 miles? (1 mile = 5280 feet)

Scenario 3: Convert 408 hours to days. (24 hours = 1 day)

Scenario 4: How many liters are in 4 quarts? (1.05 qt = 1 L)

Video: Kendrick Farris clean and jerked 197 kg, 205 kg, and 211 kg at the 2013 Worlds Championships. How many pounds did he lift each time if 2.2 lbs = 1 kg?

Multi-Step Dimensional Analysis & Applications

How many seconds are in a day?

Most of us do not know how many seconds are in a day or hours in a year. However, most of us know that there are 60 seconds in a minute, 60 minutes in an hour, and 24 hours in a day. Some problems with converting units require multiple steps. When solving a problem that requires multiple conversions, it is helpful to create a flowchart of conversions you already know, set up your conversion factors, and solve your problem.

Flowchart: Days→ Hours → Minutes → Seconds

Conversion Factors: 60 sec = 1 min, 60 min = 1 hr 24 hours = 1 day

Scenario 1: How many inches are in 3 miles? (5280 feet = 1 mile, 12 inches = 1 foot)

Scenario 2: How many centimeters are in 900 feet? (2.54 cm = 1 in, 12 inches = 1 foot)

Scenario 3: How many gallons are in 250 mL? (1 gal = 3.8 liters, 1000 milliliters = 1 liter)

Scenario 4: A rectangle has lengths of 5 cm and 100 mm. What is the perimeter & area of the rectangle in millimeters?

Rate Conversions

Most of the rates we are going to discuss today include both an amount and a time frame such as miles per hour or words per minute. When we convert our rates, we are going to change the units in **both** the numerator and denominator.

a. Mrs. Dombrowski can run about 2 miles in 16 minutes. How fast is she running in miles per hour? (Use 60 minutes = 1 hour)

b. Convert 45 miles per hour to feet per minute. (Use 5280 feet = 1 mile, 60 minutes = 1 hour)

c. Convert 36 inches per second to miles per hour. (Use 5280 ft = 1 mi, 12 in = 1 ft, 60 min = 1 hr, 60 sec = 1 min)

d. Convert 32 feet per second to meters per minute. (Use 1 in = 2.54 cm, 100 cm = 1 m, 1 ft = 12 in)

e. The top speed of a coyote is 43 miles per hour. Find the approximate speed in kilometers per minute. (Use 1 mile = 1,610 meters, 1000 m = 1 km)