Day 6: 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 = 12 inches	1 minute = 60 seconds	1 cup = 8 fl. oz	1 ton = 2000 lbs
1 yard = 3 feet	1 hour = 60 minutes	1 pint = 2 cups	1 lb = 16 oz
1 mile = 5280 feet	1 day = 24 hours	1 quart = 2 pints	
1 mile = 1760 yards	1 week = 7 days	1 gal = 4 quarts	
	1 year = 52 weeks = 365 days = 12 months	(1 $ = 4 quarters)	

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. miles → yd → ft → 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 $\frac{\text{feet}}{\text{yards}}$

$$\frac{5\text{ mi}}{1} \cdot \frac{1760\text{ yd}}{1\text{ mi}} \cdot \frac{3\text{ ft}}{1\text{ yd}} \cdot \frac{12\text{ in}}{1\text{ ft}} = \_\_\_\_\text{ in}$$

2. Convert from 94 cups to gallons. cups → pints → quarts → gal

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 $\frac{\text{quarts}}{\text{gallons}}$

$$\frac{94\text{ cups}}{1} \cdot \frac{2\text{ pints}}{2\text{ cups}} \cdot \frac{1\text{ quarts}}{2\text{ pints}} \cdot \frac{1\text{ gal}}{4\text{ quarts}} = \frac{94}{2.24}\text{ gal}$$

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Practicing Dimensional Analysis

Scenario: How many feet are in 72 inches?

Step 1: Write the given quantity with its unit of measure.	$\frac{72 in}{1} \cdot \frac{ft}{12 in} = ft$
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. $\frac{\text{what you want}}{\text{what you have}}$	$\frac{72 ft}{12} = 6 ft$
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)

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

Scenario 5: How many ounces are in 451 mL? (0.034 oz = 1 mL)

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?