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| ***Unit Conversions with Dimensional Analysis***  **Handout KEY** | **Name: Date:** |

**Objective: Learn how to convert units with Dimensional Analysis**

**Segment 1**: **Dimensional Analysis – Multiplying by the “Unit Fraction”**

Dimensional Analysis uses the concept of multiplying fractions to convert units. Let us take a simple example like 5 feet. Suppose we want to convert 5 feet into inches. For Dimensional Analysis, we will create what we call a “Unit Fraction”. A fraction where the numerator and denominator have the units we require (feet and inches in this case) but are equal to each other. In this example, we can make the unit fraction in two ways  or  . Notice that these are the values that are equal to each other. Now the key is to analyze the dimensions. (This is how we get the name Dimensional Analysis.) We are starting with 5 feet and want to turn it into inches. So the key will be to multiply by the fraction that allows you to cancel the “*feet”* units. This is the vital step to understanding Dimensional Analysis.

 . Notice how the ft units will now cancel with the ft units on the bottom of the fraction. Recall when we multiply a whole number times a fraction, to think of the whole number as over 1 and then multiply straight across. Notice the key is to cancel the units. What units are you left with after you multiply the fractions?



**Example 1 Convert 2 Miles into Feet. *(1 mile = 5280 feet)***

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**Example 2 Convert 351.4 grams into centigrams *(1 gram = 100 cg)***

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**Example 3 Convert  cups into fluid ounces *(1cup = 8 fl oz)***

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**Example 4 Convert 60 miles into kilometers *(1 mi = 1.61 km)***

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***Now it is time for you to practice. Work on the following problems using the rules discussed above. The instructor will post the answers on the board for you to check. Break up into pairs and discuss wrong answers with your partner.***

**Practice 1 Convert 48 feet into yards *(1 yd = 3 ft)***

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**Practice 2 Convert 2694 mm into meters *(1 m = 1000 mm)***

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**Practice 3 Convert 15840 feet into miles *(1 mi = 5280 ft)***

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**Practice 4 Convert 3.6 tons into pounds *(1 ton = 2000 Lbs)***

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**Practice 5 Convert 3.582 kg into grams *(1 kg = 1000 g)***

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**Practice 6 Convert 22 qt into gallons *(1 gal = 4 qt)***

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**Segment 2: Unit Conversions with Multiple Steps**

Sometimes Unit Conversions require more than one unit fraction in order to make the conversion.

Look at the following example: Suppose we want to convert 5 yards into inches. We may not know the conversion from yards to inches. We may know however that 1 yd = 3 ft and 3 ft = 12 inches. We can create two unit fractions and use them to make the conversion. Again, the key is Dimensional Analysis and making sure the units cancel. Here are some of the possible unit fractions we might use: 

The goal is to convert from yards to feet and then from feet to inches. Let’s start by deciding which unit fraction would help us get from yards to feet. Notice again, our goal is to try to get the units (yards) to cancel.



Once the yards cancel, the units will be in feet. Now we can pick an appropriate unit fraction to convert from feet to inches.



Now cancel the feet and multiply the fractions. Remember to write the whole number 5 as a fraction.



**Example 5 Convert 3.5 gallons into cups *(1 gal = 4 qt &* *1 qt = 4 cups)***



**Example 6 Convert 0.17493 Kiloliters into Deciliters *(1 kL=1000 L & 1 L = 10 dL)***

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**Example 7 Convert 1500 grams into pounds *(1 Kg = 1000 g & 1 Kg = 2.20 Lbs )***

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**Example 8 Convert 10 miles into centimeters *(1 mi = 5280 ft & 1 ft = 12 in & 1 in = 2.54 cm)***

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***Now it is time for you to practice. Work on the following problems using the rules discussed above. The instructor will post the answers on the board for you to check. Break up into pairs and discuss wrong answers with your partner.***

**Practice 7** **Convert 90 inches into yards. *(1 ft = 12 in & 1 yd = 3 ft )***



**Practice 8** **Convert 6 gallons into pints. *(1 gal = 4 qt & 1 qt = 2 pt )***



**Practice 9** **Convert 3.682 dekagrams into centigrams. *(1 dag = 10 g & 1 g = 100 cg )***

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**Practice 10** **Convert 4 feet into centimeters. *(1 ft = 12 in & 1 in = 2.54 cm )***

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**Segment 3: Converting Rates**

In many science applications rates are used. A Rate is a ratio (fraction) where the numerator and denominator have different units. So if we need to convert a rate into another rate, we will need to use dimensional analysis to convert not only the numerator but also the denominator. The most common types of rates usually involve units of time. Look at the rate of 50 miles per hour (mph). Suppose we want to convert that speed to feet per minute. This is another common unit for speed. There are 5280 feet in 1 mile and 60 minutes in 1 hour. So possible unit fractions might be



Let us start by finding a unit fraction that will convert the miles to feet.



Notice the miles in the numerator will cancel with the miles in the denominator. We now have feet in the numerator, but we now need to convert the hours in the denominator. So let us find another unit fraction that will cancel the hours.



Now we can cancel the hours and we will be left with minutes in the denominator. We will then multiply the fractions to get our answer.



Hence 50 miles per hour is the same as 4400 feet per minute.

**Example 9 Convert 0.12 fl oz per minute of medicine into mL per second.   
*(1 fl oz = 29.57 mL & 1 min = 60 sec )***



**Example 10 Ethylene glycol has a density of 1.11 grams per  . Convert this density into hg per liter .**

***(1 hg = 100 g & 1 L = 1000*  )**



***Now it is time for you to practice. Work on the following problems using the rules discussed above. The instructor will post the answers on the board for you to check. Break up into pairs and discuss wrong answers with your partner.***

**Practice 11 Convert 80 km per hour into miles per hour (mph). *(1 km = 0.62 mi )***

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**Practice 12 Convert 4.8 miligrams per day into micrograms per hour.   
*(1 mg = 1000 mcg & 1 day = 24 hours )***



**Quiz:** Let’s check to see how much you have learned. Take the quiz. Then check your answers.

When you are done, answer the following self-reflection questions.

**SELF-REFLECTION**

-What do you think is the most difficult part of unit conversions and Dimensional Analysis? Do you think a better understanding of fractions would help?

-What steps might you take to get better at converting units?