Name _____ Date _____ Period _____

Furrey

How do I do that unit conversion?

There are two fundamental types of unit conversions in dimensional analysis. One is converting old units to new units with in the same system of measurements. The other is converting old units in one system of measurements to new units in a different system of measurements. How is the conversion made? The method used for unit conversions is the **factor label** method and the fundamental steps are:

1. Have your conversion chart. (The chart shows how many grams are in a kilogram, etc.)
2. Identify the old number and old units. (What is the number and units you are starting with?)
3. Identify the new units. (What is the unit you want to end with?)
4. Make a "bridge" between units. (The bridge is the conversion factor(s) required to get from the old units to the new units.)

Example 1: How many grams are in 12.4 kilograms? or 12.4 kg = _____ g

The base units in this problem are **_grams** _____.

1. The conversion chart of prefixes and suffixes shows that the prefix *kilo-* has a multiplier of 1000.

(a partial conversion chart)

Prefix	Multiplier to get base unit
kilo-	1000
centi-	.01
milli-	.001

2. The old number and units, what we are starting with, is **__12.4 kg** ___. This is placed over 1 as shown: $\frac{12.4kg}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_gram or g** _____.

4. Make a "bridge" between the old units and new units. How many grams are in a kilogram? **_1000** _. 1000g = 1kg. Set up the conversion factor, the "bridge". A conversion factor is one item divided by another item that **always** equals **1** like this: $\frac{1000g}{1kg} = 1$ or $\frac{1kg}{1000g} = 1$.

Which one do I use? These are both the same and both are equal to one. Choose the conversion factor that has the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{12.4kg}{1} \times \frac{1000g}{1kg}$ = 12,400g … on top: 12.4 x 1000 = 12,400; on bottom: 1 x 1 = 1; the top is divided by the bottom, $\frac{12,400}{1}$, the **kg** units on top is canceled by the **kg** units on bottom leaving the final answer with the new units **__12,400g** _____.

Example 2: How many liters are in 1250 milliliters? or 1250ml = _____ liters

The base units in this problem are **_liters** _____.

1. The conversion chart of prefixes and suffixes shows that the prefix *milli-* has a multiplier of .001.

(a partial conversion chart)

Prefix	Multiplier to get base unit
kilo-	1000
centi-	.01
milli-	.001

2. The old number and units, what we are starting with, is **__1250ml** ___. This is placed over 1 as shown: $\frac{1250ml}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_liter or l**_____.

4. Make a "bridge" between the old units and new units. How many milliliters are in a liter? **_1000** _. 1000ml = 1l. Set up the conversion factor, the "bridge". A conversion factor is one item divided by another item that **always** equals **1** like this: $\frac{1000ml}{1l} = 1$ or $\frac{1l}{1000ml} = 1$.

Which one do I use? These are both the same and both are equal to one. Choose the conversion factor that has the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{1250ml}{1} \times \frac{1l}{1000ml}$ = 1.25 liters … on top: 1250 x 1 = 1250; on bottom: 1 x 1000 = 1; the top is divided by the bottom $\frac{1250}{1000}$, the **ml** units on top is canceled by the **ml** units on bottom leaving the final answer with the new units **__1.25 liters** _____.

Example 3: How many centimeters are in 21.298 Kilometers? or 21.298 km = _____ cm

The base units in this problem are **_meters** _____.

1. The conversion chart of prefixes and suffixes shows that the prefix *centi-* has a multiplier of .01 and *kilo-* has a multiplier of 1000. This example has **two** different prefixes … hmmmmmm ….

(a partial conversion chart)

Prefix	Multiplier to get base unit
kilo-	1000
centi-	.01
milli-	.001

2. The old number and units, what we are starting with, is **__21.298 km** ___. This is placed over 1 as shown: $\frac{12.298km}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_centimeter or cm** _____.

4. Make a "bridge" between the old units and new units. How many centimeters are in a kilometer? **_hmmmm, the chart does not show this, BUT it shows centi- to base units and it shows base units to kilo-**_. 100cm = 1m and 1000m = 1km. Set up **two** conversion factors, in the "bridge", one conversion factor is from kilometers to meters and the second conversion factor is from meters to centimeters. Remember, a conversion factor is one item divided by another item that **always** equals **_1** _. The **two** conversion factors are: $\frac{100cm}{1m} = 1$ or $\frac{1m}{100cm} = 1$ **and** $\frac{1000m}{1km}$ or $\frac{1km}{1000m}$.

Which one of each pair do I use? Choose the conversion factors that have the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{21.298km}{1} \times \frac{1000m}{1km} \times \frac{100cm}{1m}$ = 2,129,800 cm. Take a logical progression when using multiple conversion factors. In this example, flow from the largest units to the smallest units, **km > m > cm**. On top: 21.298 x 1000 x 100 = 2,129,800; on bottom: 1 x 1 x 1 = 1; the top is divided by the bottom $\frac{2,129,800}{1}$, the **km** units on top is canceled by the **km** units on bottom and the **m** units on top is canceled by the **m** units on bottom leaving the final answer with the new units **_2,129,800 cm** ___.

Example 4: How many kilograms are in 48,550,000 milligrams? or 48,550,000mg = _____ kg

The base units in this problem are **_grams** _____.

1. The conversion chart of prefixes and suffixes shows that the prefix *milli-* has a multiplier of .001 and *kilo-* has a multiplier of 1000. This example also has **two** different prefixes.

(a partial conversion chart)

Prefix	Multiplier to get base unit
kilo-	1000
centi-	.01
milli-	.001

2. The old number and units, what we are starting with, is **__48,550,000 ml** ___. This is placed over 1 as shown: $\frac{48{,}550{,}000mg}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_kilogram or kg** _____.

4. Make a "bridge" between the old units and new units. How many kilograms are in a milligram? **_hmmmm, once again, the chart does not show this, BUT it shows milli- to base units and it shows base units to kilo-** _ 1000mg = 1g **and** 1000g = 1kg. Set up **two** conversion factors, in the "bridge", one conversion factor is from kilometers to meters and the second conversion factor is from meters to millimeters. Remember, a conversion factor is one item divided by another item that **always** equals **_1** _. The **two** conversion factors are: $\frac{1000mg}{1g} = 1$ or $\frac{1g}{1000mg} = 1$ **and** $\frac{1000g}{1kg}$ or $\frac{1kg}{1000g}$.

Which of each pair do I use? Choose the conversion factors that have the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{48{,}550{,}000mg}{1} \times \frac{1g}{1000mg} \times \frac{1kg}{1000g} =$ 48.55 kg. Take a logical progression when using multiple conversion factors. In this example, flow from the smallest units to the larges units, **mg > g > kg.** On top: 48,550,000 x 1 x 1 = 48,550,000; on bottom: 1 x 1000 x 1000 = 1,000,000; the top is divided by the bottom, $\frac{48{,}550{,}000}{1{,}000{,}000}$ the **mg** units on top is canceled by the **mg** units on bottom and **g** units on top is canceled by **g** units on bottom leaving the final answer with the new units **__48.55 kg** _____.

The first four examples have been with in the metric system of measurements. The next series of examples will be English to metric and metric to English conversions. There is not really a "base" unit in the English system of units because there is no such thing as a base 10 or multiple of 10 in the English system of units. An example is length. The units for length in the English system of measurements are inches, feet, yards and miles.

Example 5: How many miles are in 10 kilometers? or 10 km = _____ miles

The base units in this problem are **_meters to miles** _____.

1. The conversion chart below shows a few of the conversions between the metric system and the English system of measurements.

	You have:	Multiply by:	To find:
Length	inches	2.54	centimeters (cm)
	centimeters	0.39	inches
	feet	0.30	meters
	meters	3.28	feet
	miles	1.61	kilometers
	kilometers	0.62	miles

	You have:	Multiply by:	To find:
Mass and Weight*	ounces	28.35	grams
	grams	0.04	ounces
	pounds	0.45	kilograms
	kilograms	2.20	pounds

* Weight as measured in standard Earth gravity

	You have:	Multiply by:	To find:
Volume	liters	1.06	quarts
	liters	0.26	gallons
	gallons	3.78	liters

2. The old number and units, what we are starting with, is **__10 km** ___. This is placed over 1 as shown: $\frac{10km}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_miles** _____.

4. Make a "bridge" between the old units and new units. How many miles are in a kilometer? **_0.62** _. 1 km = 0.62 miles. Set up the conversion factor, the "bridge". A conversion factor is one item divided by another item that **always** equals **1** like this: $\frac{0.62miles}{1km}$ = 1

There is only one conversion factor that will work to go from kilometers to miles. The conversion factor will have the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{10km}{1}$ x $\frac{0.62miles}{1km}$ = 6.2 miles … on top: 10 x 0.62 = 6.2; on bottom: 1 x 1 = 1; the top is divided by the bottom, $\frac{6.2}{1}$, the **km** units on top is canceled by the **km** units on bottom leaving the final answer with the new units **__6.2 miles** _____. A popular running race is the "10K" which is 10 kilometers. Perhaps you have run in one of these races and always wanted to know how many miles you ran.

Example 6: How many pounds are in 48.55 kg? or 48.55 kg = _____ lbs

The base units in this problem are **_grams and pounds** _____.

1. The conversion chart below shows a few of the conversions between the metric system and the English system of measurements.

	You have:	Multiply by:	To find:
Length	inches	2.54	centimeters (cm)
	centimeters	0.39	inches
	feet	0.30	meters
	meters	3.28	feet
	miles	1.61	kilometers
	kilometers	0.62	miles

	You have:	Multiply by:	To find:
Mass and Weight*	ounces	28.35	grams
	grams	0.04	ounces
	pounds	0.45	kilograms
	kilograms	2.20	pounds

* Weight as measured in standard Earth gravity

	You have:	Multiply by:	To find:
Volume	liters	1.06	quarts
	liters	0.26	gallons
	gallons	3.78	liters

2. The old number and units, what we are starting with, is **__48.55 kg** ___. This is placed over 1 as shown: $\frac{48.55g}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_pounds or lbs** _____.

4. Make a "bridge" between the old units and new units. How many pounds are in a kilogram? **_2.2** _. 1 kg = 2.2 lbs. Set up the conversion factor, the "bridge". A conversion factor is one item divided by another item that **always** equals **1** like this: $\frac{2.2lbs}{1kg} = 1$

There is only one conversion factor that will work to go from kilograms to pounds. The conversion factor will have the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{48.55kg}{1} \times \frac{2.2lbs}{1kg} = 106.81\text{lbs}$ … on top: 48.55 x 2.2 = 106.81; on bottom: 1 x 1 = 1; the top is divided by the bottom, $\frac{106.81}{1}$, the **kg** units on top is canceled by the **kg** units on bottom leaving the final answer with the new units **__106.81 lbs** _____.

Example 7: How many liters are in 22 gallons? or 22 gallons = _____ liters

The base units in this problem are **_gallons to liters** _____.

1. The conversion chart below shows a few of the conversions between the metric system and the English system of measurements.

	You have:	Multiply by:	To find:
Length	inches	2.54	centimeters (cm)
	centimeters	0.39	inches
	feet	0.30	meters
	meters	3.28	feet
	miles	1.61	kilometers
	kilometers	0.62	miles

	You have:	Multiply by:	To find:
Mass and Weight*	ounces	28.35	grams
	grams	0.04	ounces
	pounds	0.45	kilograms
	kilograms	2.20	pounds

* Weight as measured in standard Earth gravity

	You have:	Multiply by:	To find:
Volume	liters	1.06	quarts
	liters	0.26	gallons
	gallons	3.78	liters

2. The old number and units, what we are starting with, is **__22 gallons** ___. This is placed over 1 as shown: $\frac{22 gallons}{1}$. This helps to visually organize the conversion to new units. We know that anything divided by 1 is always itself.

3. The new units, what we want to end with, is **_liters** _____.

4. Make a "bridge" between the old units and new units. How many liters are in a gallon? **_3.78** _.
1 kg = 2.2 lbs. Set up the conversion factor, the "bridge". A conversion factor is one item divided by another item that **always** equals **1** like this: $\frac{3.78l}{1 gallon} = 1$

There is only one conversion factor that will work to go from gallons to liters. The conversion factor will have the **new units in the numerator** (top) and the **old units in the denominator** (bottom). When you **multiply**, you want to **keep the new units** and **cancel the old units**.

$\frac{22 gallons}{1} \times \frac{3.78l}{1 gallon} = 83.16$ liters … on top: 22 x 3.78 = 83.16; on bottom: 1 x 1 = 1; the top is divided by the bottom, $\frac{83.16}{1}$, the **gallon** units on top is canceled by the **gallon** units on bottom leaving the final answer with the new units **__83.16 liters** _____. When driving in a different country other than the United States or England and you need to fill the gas tank, the gas pump will be calibrated in liters and not gallon. You will know the volume of gas you are putting into the tank