Chapter 4

International (SI) Units of Measure

In this chapter, you will learn the following to World Class standards:

- ☑ Introducing the Metric Units of Measurement
- ☑ Converting between the Two Systems of Measurement
- ☑ Converting Length Measures
- ☑ Solve Real Kitchen Exercises

Lesson 4-1:
Introducing the Metric Units of Measurement

People throughout the world predominantly use the Metric System as their method of measuring. For volume, they use the liter, for mass, they utilize the gram and for length the meter is the measurement of choice. There are three countries still using the English system and they are the United States, Liberia and Burma. The rest of the world uses the Metric system. Although the United States is still using the English system, they really use both. Whole industries converted to using metric values as their mode of measuring. The automotive, electronics (computer) and aviation companies primarily employ the metric system. As a chef, when shopping, metric units may be the most important measurement to us and the English system will be in parenthesis.

In the kitchen, expect to see both systems for some time. Imported products definitely are metric and locally made and packaged items that the company wants to ship outside the region will have metric markings. The metric system is surprisingly easy to use. Almost everyone already knows the liter and two-liter size since their favorite beverage is in one of these containers. The meter is very close to the yard and the largest employer in the United States, the U.S. military has been using that metric length for years. In the kitchen, we may have some challenges determining 230 grams or 0.5 pound of salmon, but with practice, we will be able to estimate metric masses as we do with English weights.

While the English system of measurement has a multitude of names for various container sizes, the Metric system has one root called the liter. We can purchase standard vessels that hold a certain amount of liters just as we do in the English volumetric system, however only the number showing the magnitude and the prefix in front of the root "liter" changes.

For example, close to the U.S. cup (237 ml) is the 250-milliliter metric cup. The value 250 is the quantity and the "milli" ($^1/_{1000}$) is the size of the increment of the larger liter container. All the division prefixes in the metric system are factors of 10. The following table examines the prefix name, abbreviation, and mathematical comparison to the single unit, one liter.

Prefix – Root	Abbreviation	Multiplier
Kiloliter	kl	1000
Hectoliter	hl	100
Decaliter	dal	10
Liter	L	1
Deciliter	dl	$^1/_{10}$
Centiliter	cl	$^1/_{100}$
Milliliter	ml	$^1/_{1000}$

The **liter** container is the standard unit of measurement in the metric system. The liter contains 33.81 fluid ounces, which is very close to the U.S. quart of 32 fluid ounces. The most common uses of the metric volume measurement is the liter (L) and milliliter (ml) The abbreviation for the liter is capital "L" and for the milliliter "ml".

A Quart (Qt) is 0.9465 of a Liter (L)

The **gram** is the standard unit of mass in the metric system. In the U.S., we measure a product by weight using the pound in the English system, and the rest of the people in the world measures by mass using grams. Now, this difference is of no consequence on the planet Earth since we have the same gravity, however the difference would be dramatically changed when serving meals on the International Space Station. In other words, the pound is gravity driven and the gram is not.

Kilogram (kg) of Steak is 2.21 lbs

There are 28.35 grams in an ounce and we measure 2.205 lbs in a kilogram. The most common uses of the metric volume measurement is the kilogram (kg) and gram (g) The abbreviation for the gram is a lower case "g" and for kilogram "kg".

The **meter** is the standard unit of length in the metric system. . The most common uses of the metric volume measurement is the kilometer (km), the meter (m), the centimeter (cm) and the millimeter (mm) The abbreviation for the meter is a lower case "m", kilometer is "km", centimeter is "cm" and millimeter is "mm".

The following table shows the comparison of volume, weight and length measurements and the conversion factors used between the two systems.

English to Metric Conversions			
	English	**Metric**	**Conversion**
Volume	Gallon, half gallon, quart, pint, cup, 1/2 cup, 1/4 cup, fluid ounce, tablespoon, teaspoon	Kiloliter, Liter, milliliter	1 Liter = 33.81 fl. oz. 1 tbsp = 15 ml 1 tsp = 5ml 1 cup = 236.6 ml
Weight	Pound, ounce, ton	Kilogram, gram	28.35 grams = 1 oz 2.205 lbs = 1 kg
Length	Inches, feet, yards, miles	Kilometers, meters, centimeters, millimeters	2.54 cm = 1 inch, 39.37 inches = 1 meter 1 mile = 1.609 km

Some of the conversion factors have been rounded for ease of use. For example, as we see in the conversion bracket below, there are 4.93 ml to a teaspoon. In the conversion table, we round the 4.93 ml to 5 ml, which is a 98.6% accurate answer.

$$\frac{1tsp}{1} \times \frac{1tbsp}{3tsp} \times \frac{8\,fl.oz.}{16tbsp} \times \frac{1000ml}{33.81\,fl.oz.} = 4.93\text{ml}$$

Whenever we need to translate a value, use the conversion factor that is closest to the container we wish to convert. So do not use the 5 ml equals one teaspoon when changing one gallon to liters. The margin of error will be great.

Practice Problems

Convert the following units to their equivalent volume measurements.

1000 ml =	___ Liter	28.35 g =	___ oz	250 ml =	___ Liters
100 cm =	___ m	1000 m =	___ km	2 tbsp =	___ ml
3 tsp =	___ ml	33.81 fl. oz. =	___ Liter	0.001 kg =	___ g
2.205 lbs =	___ kg	1000 g =	___ kg	25.4 mm =	___ inch
500 ml =	___ Liter	2.54 cm =	___ inch	10 mm =	___ cm
15 ml =	___ tbsp	5 ml =	___ tsp	237 ml =	___ cup

Real Kitchen Exercise

Chef Harms wants to know how many cups of oil we can get from a container holding 3.5 quarts of oil.

We have just received 2 cases of wine holding 12 – 750ml bottles. Chef Harms wants to know how many 4 fl.oz. servings we can get from the two cases of wine.

Lesson 4-2
Converting between English and Metric Systems

When we need to convert from one system of measurement to another, we need a method to help us accomplish the task. The technique we will utilize is called the Unit – Factor method. In our first example, we will change 2 ½ gallons to liters. Place the 2 ½ gallons in the numerator over 1 in the denominator of the first fraction.

$$\frac{2\frac{1}{2}\,gal}{1}$$

Since we know that one gallon equals 128 fluid ounces from chapter 2, we write 1 gallon in the denominator of the next fraction and the 128 fluid ounces in the numerator. In every case, each successive fraction in the conversion process, the numerator will be equivalent to the denominator.

$$\frac{2\frac{1}{2}\,\cancel{gal}}{1}\times\frac{128\,fl.oz.}{1\,\cancel{gal}}$$

Now, we see that the gallons cross or divide each other and we have fluid ounces remaining, so we write 33.81 fluid ounces on the bottom of the next fraction and 1 liter at the top. We cross the fluid ounces out and the unit we have left is the liter.

$$\frac{2\frac{1}{2}\,\cancel{gal}}{1}\times\frac{128\,\cancel{fl.oz.}}{1\,\cancel{gal}}\times\frac{1\,liter}{33.81\,\cancel{fl.oz.}}$$

Now that we have the unit we desire, we compute the answer by multiplying across the top to get 320 and we multiply across the bottom to get 33.81. Divide 320 by 33.81 and we have 9.46465543 on our calculator. We round to a tenth of a liter and the six on the hundredths place is five and above, so we round the four up to five.

$$\frac{2\frac{1}{2}\,\cancel{gal}}{1}\times\frac{128\,\cancel{fl.oz}}{1\,\cancel{gal}}\times\frac{1\,liter.}{33.81\,\cancel{fl.oz}}=\frac{320}{33.81}=9.5\,liters$$

When doing the work throughout the textbook and in our career, we do not have to cross out the units as shown in this example. We know that the units divide out and the numerator in last fraction is the unit we will write with the numeric value.

Converting Pounds to Kilograms

When chef gives us the weight of a commodity such as 5 pounds of cheddar cheese and we would like to convert the measurement to kilograms, we need to divide the measurement by 2.205 since there are 2.205 pounds in a kilogram. In the conversion below, we can see the steps to change the pounds to kilograms.

$$\frac{5lb}{1} \times \frac{1kg}{2.205lb} = \frac{5}{2.205} = 2.28kg$$

So the formula for converting pounds to ounces is:

$$\frac{\underline{\quad\quad} lb}{1} \times \frac{1kg}{2.205lb} = \underline{\quad\quad} kg$$

And all we have to do is insert the pounds or pounds-decimal and divide by 2.205 to get the number of kilograms.

Converting Ounces to Grams

At this moment, the executive chef wants four-ounce servings of cream cheese for the hors d'oeuvres, and we want to convert the ounces to grams. In this conversion, we will multiply the four ounces by a factor of 28.35 to get grams.

$$\frac{4oz}{1} \times \frac{28.35g}{1oz} = \frac{113.4}{1} = 113.4g$$

So the formula for converting ounces to grams is:

$$\frac{\underline{\quad\quad} oz}{1} \times \frac{28.35g}{1oz} = \underline{\quad\quad} g$$

Many times, professionals ask us where to round the answer for their recipes. The answer is to know about the type of scales available in the kitchen. If our kitchen scale can measure grams to the tenth of a gram, then round the answer to that level of accuracy.

Practice Problems

What are the abbreviations for the following measurements:

Millimeter		Meter	
Kilogram		Gram	
Centimeter		Kilometer	
Milliliter		Liter	

Chef's recipe calls for 2.5 liters of broth. How many fluid ounces of broth does chef need?

Chef wants to know how many cups of oil we can get from a container holding 3.5 liters of oil.

Chef wants to know how many 2-ounce servings we can get from 10 kilograms of chocolate.

Lesson 4-3
Measuring by Length

Most people find that reading a metric linear scale is quite simple and easier to do than deciphering the English ruler. The metric scale has whole numbers indicating the larger division and these units are called centimeters. In between the centimeters marks are millimeters.
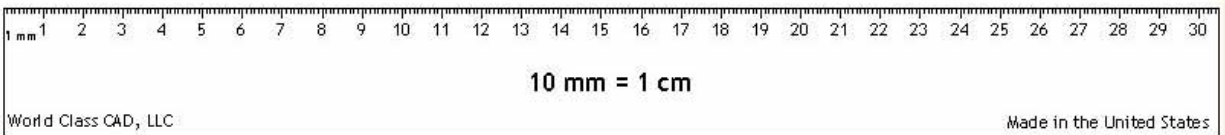

Centimeter Scale (cm)

Remember, the metric system is a decimal scale where each smaller unit is one tenth of the preceding unit. In our scale shown above the centimeter marks have numeric labels 1,2,3 …. all the way to 30. In between the centimeter's larger markings are 10 partitions, each representing a millimeter. There are 10 millimeters in a centimeter.
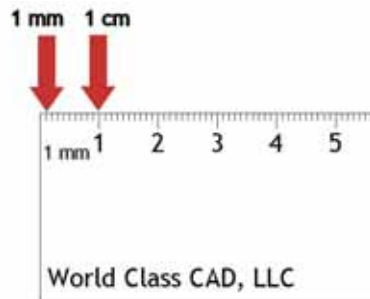
1 mm and 1cm

When measuring a food item with the metric scale, place the scale at one end of the piece and then read the number of centimeters. In the example, the number of centimeters is 3. Then read the number of millimeters. The number of millimeters in the example is 7. The answer is 3 centimeters and 7 millimeters or 3.7 centimeters.
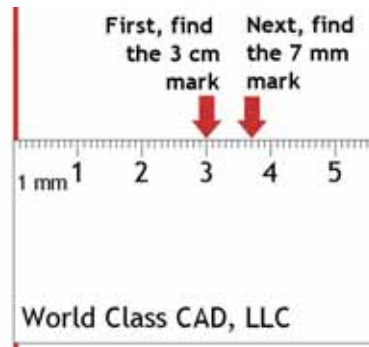
Measuring 3.7 cm

Practice Problem

Chef is slicing the sausage in the stew 5 cm long. How many inches long should cut the sausage?

4-8

Lesson 4-4
Real Kitchen Exercise

1. The Extra Virgin Olive Oil (EVOO) comes in a half-liter bottle. We use 2 tablespoon in each recipe of Pilgrim Pumpkin Soup. How many 2-tablespoon servings can we get from the bottle?

2. A recipe for Baba Ganoush (roasted eggplant) calls for 2 kilograms of eggplant. How much is the eggplant in pounds?

3. There are 250 g of salmon fillets in chef's recipe. How many pounds of salmon would Chef need for the Fresh Salmon Coulibiac?

Math for Culinary Professionals

4. How many 4 fluid ounce servings of Chardonnay can we get from a 750 ml wine bottle?

5. We have a box of blackstrap molasses that holds eight 16 oz jars. If the recipe for cookies calls for 4 ounces of molasses, how many batches can we make from the one box shipment?

6. Chef asks you to determine the amount of 4 fluid ounce servings you can get from 10 cases of Champaign. There are 12 – 750 ml bottles in each case.

7. Chef has forty-eight 7-oz steaks. What is the total weight of the steaks in kilograms?

8. The Westside elementary school orders milk every afternoon for the next day. 32 kindergartners drink six fluid ounces of milk each day. There are 89 students in first through third grade, who drink 8 fluid ounces of milk for lunch each day. 42 students eat breakfast each morning and they consume 10fl. Oz. per child. What is the total in fluid ounces required for the next day? How many gallons of milk do we need to order?

9. Chef asks you to spread cream cheese on each of 500 hors d'oeuvres. Each of the hors d'oeuvre has a 10 ml of cream cheese. How many cups of cream cheese are required?

10. The chef is making cream of corn soup in the kitchen. The recipe calls for 1 $\frac{2}{3}$ cups of sweet corn, 6 ¼ cup of chicken stock, ½ cup of chopped onion, ½ cup of diced carrots, ½ cup of diced celery, ¼ cup of pure olive oil, and ½ cup of whipping cream. How many cups of soup will the chef make?

11. What are the abbreviations for the following measurements:

Fluid Ounce		Foot		Pound	
Kilometer		Centimeter		Liter	
Tablespoon		Cup		Kilogram	
Gallon		Quart		Milliliter	
Pint		Ounce		Meter	
Inch		Gram		Teaspoon	