Units
Time & Temperature

In Culinary Arts, the five very important measurements are Volume (fluid or liquid), Weight, Length, Temperature and Time. Fortunately, Time is measured the same everywhere! Temperature is measured in only two systems, the Celsius (Centigrade) system and the Fahrenheit system. The conversion between each of these systems is straightforward. The conversion formulas are: 

\[ F = \frac{9}{5} C + 32 \quad \text{and} \quad C = \frac{5}{9} (F - 32) \]

Example 1: from Celsius to Fahrenheit
Convert 200º C to Fahrenheit.
\[
F = \frac{9}{5} * 200 + 32 = 360 + 32 = 392
\]
Therefore, 200º C is the same as 392º F.

Example 2: from Fahrenheit to Celsius
Convert 350º F to Celsius.
\[
C = \frac{5}{9} (350 - 32) = \frac{5}{9} (318) = \frac{1590}{9} = 176.7
\]
Therefore, 350º F is equivalent to 176.7º C.

Volume, Weight & Length

Quoting from *The Book of Yields*, page 36-1:

The 3 “western” measurement systems are: metric, American (United States) and British (Imperial). The Imperial and U.S. systems both use equivalent pounds and ounces to measure weights. This system is called avoirdupois. The word “avoirdupois” simply means “goods of weight”. It is a measuring system for weight (mass). ... HOWEVER, when measuring FLUID ounces the American and the Imperial Fluid Ounce DIFFER!

This difference between the American and Imperial Fluid Ounce is distinctly inconvenient, but avoidable. After providing a fascinating summary of why these measurement differences exist, *The Book of Yields* states:

Thankfully, the 3rd system, the Metric, is far more simple and logical. The Metric system links the way we measure distance, weight, area and
volumes. Being consistent, the Metric system is used to compare the U.S. and Imperial systems to each other.

The Metric system does indeed simplify your life and mine! We can use the metric system to convert between each system. However, we are going to concentrate just on the U.S. and Metric systems of measurements.

In Culinary Arts, you frequently convert from one unit to another. Sometimes you work with weights such as ounces and pounds (US) or grams, decigrams and kilograms (Metric). Sometimes you work with liquid volumes such as cups, quarts and gallons (US) or milliliters, centiliters or kiloliters (Metric). Often food is bought by weight, but chefs prefer to use the food with volume measures as it makes recipes easier to follow. Also in Culinary Arts, you need to determine the quantity of a food sold by weight measures, so you can order the correct amount for a recipe using volume measures or sold by volume when using a recipe giving ingredients by weight. Bakers usually use weight measurement, as this tends to keep recipes more consistent and accurate. Finally, sometimes it is necessary to convert from the U.S. units to the metric units or vice-versa.

In Culinary Arts, the Volume units (cubic inches, cubic centimeters, etc.) are not used very often and will not be discussed here. What is used in the Culinary Arts field is Fluid Volume. Fluid Volume is also called Capacity and is used all the time. Fluid Volume or Capacity is used when measuring liquids. Here are some standard U.S. and metric measurement conversions. These tables are by no means exhaustive. (This is just a taste of conversions…)

### U.S. Measures of Fluid Volume (Capacity)
- ½ pinch ~ 1/8 teaspoon (tsp or t)
- 3 teaspoons = 1 tablespoon (tbsp or T)
- 16 tablespoons = 1 cup (C)
- 2 cups = 1 pint (pt)
- 2 pints = 1 quart (qt)
- 4 quarts = 1 gallon (gal)

### U.S. Measures of Weight (Mass)
- 16 ounces (oz) = 1 pound (lb)
- 2000 pounds = 1 ton

### U.S. Measures of Length
- 12 inches (in) = 1 foot (ft)
- 3 feet (ft) = 1 yard (yd)
- 5280 feet = 1 mile (mi)

### Metric Measures: Capacity (Fl. Vol.) to Weight (Mass)
- kiloliter = kl
- hectoliter = hl
- dekaliter = dal
- liter = l
- deciliter = dl
- centiliter = cl
- milliliter = ml
- kilogram = kg
- hectogram = hg
- dekagram = dag
- gram = g
- decigram = dg
- centigram = cg
- milligram = mg

The conversion is done by relocating the decimal. Review topic F6 to remind yourself of how to use the prefix table to change a measurement from one unit to another unit within the metric system.
Prefix Table:

<table>
<thead>
<tr>
<th>k</th>
<th>h</th>
<th>da</th>
<th>d</th>
<th>c</th>
<th>m</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo-</td>
<td>hecto-</td>
<td>deka-</td>
<td>basic</td>
<td>deci-</td>
<td>centi-</td>
</tr>
<tr>
<td>no prefix</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remember: the liter measures liquid volume; the gram measures mass (weight); the meter measures length.

Fluid Volume (Capacity) – U.S. & Metric Conversions

- 1 fl. oz  =  29.5735 ml
- 1 fl. gal.  =  3.78541 l
  - 1 ml = .033814 fl. oz.
  - 1 l = .26417 gal.

Recall, avoirdupois (avdp) means the measure is a weight, not volume. Avoirdupois helps us distinguish between the U.S. fluid ounce (volume) and the U.S. ounce (weight). The U.S. fluid ounce (volume) is 1.22 grams heavier than the U.S. ounce weight. This is confusing. So if you see fluid ounces, you know the reference is to volume. If you see ounces (avdp) you know the reference is to weight. If you see just ounces, you will have to carefully look at the context to determine whether the recipe is referring to weight (avdp) or volume.

Fluid Volume (Capacity) to Mass - U.S. & Metric Conversions

- 1 fl. C = 8 ounces (avdp)
- 1 fl. C = 236.6 g

Note: For water or other liquids that have about the same density, 1 ml of the liquid has a mass of 1 g. So 1 ml of milk would have a mass of 1 g since milk is mostly water.

Weight (Mass) - U.S. & Metric Conversions

- 1 ounce (avdp)  =  28.34952 g
- 1 pound (avdp)  =  453.592 g
  - 1 kg  =  35.27396 ounces (avdp)
  - 1 kg  =  2.2046 pounds (avdp)

Length - U.S. & Metric Conversions

- 1 in.  =  2.54 cm
- 1 ft    =  30.48 cm
- 1 cm   =  .3937 in.
- 1 m    =  39.37 in.

Few examples/problems of conversions within each measurement system will be given as these problems are explained in Topic F6.1 online at the Academic Systems’ website and in the homework from your Personal Academic Notebook (the textbook). Most of the problems will involve converting between the two systems, U.S. and Metric. A few will involve converting all units in a recipe to measures of weight.
Example 3: converting from metric to U.S. units

The ingredients listed for a recipe for “Sautéed Sole with Preserved Mango Chutney and Grilled Bananas” (taken from *Techniques of Healthy Cooking*, page 347) are listed below. Convert the recipe to the appropriate U.S. units.

<table>
<thead>
<tr>
<th>Metric Measure</th>
<th>U.S. Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilogram</td>
<td>Sole fillets, trimmed</td>
</tr>
<tr>
<td>40 milliliters</td>
<td>Skim milk</td>
</tr>
<tr>
<td>30 grams</td>
<td>Bread crumbs, dry</td>
</tr>
<tr>
<td>30 grams</td>
<td>Butter, whole, unsalted</td>
</tr>
<tr>
<td>450 grams</td>
<td>Preserved Mango Chutney</td>
</tr>
<tr>
<td>700 grams</td>
<td>Bananas, sliced on bias, grilled</td>
</tr>
</tbody>
</table>

For the trimmed sole fillets: Since 1 kilogram = 35.27396 ounces (avdp),

\[
1 \text{ kg} \times \frac{35.27396 \text{ oz (avdp)}}{1 \text{ kg}} = 35.27396 \text{ oz (avdp)}
\]

so \(35.27396 \text{ oz (avdp)} \times \frac{1 \text{ pound (avdp)}}{16 \text{ ounces (avdp)}} \approx 2.2 \text{ pounds (avdp)} \) or 2¼ lbs (avdp)

(Note: “~” means “approximately equals”.)

OR

For the trimmed sole fillets: Since 1 pound (avdp) = .453592 kg,

\[
1 \text{ kg} \times \frac{1 \text{ lb (avdp)}}{.453592 \text{ kg}} \approx 2.2 \text{ pounds (avdp)}
\]

Notice that if you have any relationship, then you can write the ratio unit for conversion.

Now let’s finish converting the rest of the ingredients on our list to U.S. units.

For the skim milk: Since 1 ml = .033814 fl. oz.,

\[
40 \text{ ml} \times \frac{.033814 \text{ fl. oz.}}{1 \text{ ml}} \approx 1.4 \text{ fl. oz.} \text{ (or perhaps, 1½ fl oz)}
\]

For dry bread crumbs: Since 1 oz (avdp) = 28.34952 g,

\[
30 \text{ g} \times \frac{1 \text{ oz (avdp)}}{28.34952 \text{ g}} \approx 1 \text{ oz (avdp)}
\]

For whole, unsalted butter: Since 1 fl. C. = 236.6 g and 1 fl C = 16 tbsp,

\[
30 \text{ g} \times \frac{1 \text{ fl. C}}{236.6 \text{ g}} \times \frac{16 \text{ tbsp}}{1 \text{ fl C}} \approx .2 \text{ tbsp}
\]

Since 3 tsp = 1 tbsp, .2 tbsp \(\times\) \(\frac{3 \text{ tsp}}{1 \text{ tbsp}} = .6 \text{ tsp or } \approx \frac{1}{2} \text{ tsp}

For preserved mango chutney: Since 1 lb = 453.593 g,

\[
450 \text{ g} \times \frac{1 \text{ lb (avdp)}}{453.592 \text{ g}} \approx 1 \text{ pound (avdp)}
\]
For the bananas: Since 1 lb = 453.592 g,

\[
700 \text{ g} \times \frac{1 \text{ lb} \text{(avdp)}}{453.592 \text{ g}} \approx 1.5 \text{ pound (avdp)}
\]

So the converted recipe is now:

2.2 pounds   Sole fillets, trimmed  
1.4 fluid ounces   Skim milk  
1 ounce   Bread crumbs, dry  
½ tsp   Butter, whole, unsalted  
1 pound  Preserved Mango Chutney  
1½ pounds   Bananas, sliced on bias, grilled

Problems

1. Convert this recipe for “Wild Rice Salad” (taken from Techniques of Healthy Cooking, page 259) to the appropriate U.S. units.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>U.S. Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild rice</td>
<td>400 grams</td>
</tr>
<tr>
<td>Stock or water</td>
<td>As needed</td>
</tr>
<tr>
<td>Vinaigrette</td>
<td>150 milliliters</td>
</tr>
<tr>
<td>Granny Smith apples, cored, julienne</td>
<td>140 grams</td>
</tr>
<tr>
<td>Red pepper, julienne</td>
<td>140 grams</td>
</tr>
<tr>
<td>Walnuts, toasted</td>
<td>40 grams</td>
</tr>
<tr>
<td>Apple Cider</td>
<td>45 milliliters</td>
</tr>
<tr>
<td>Shallots, minced</td>
<td>15 grams</td>
</tr>
<tr>
<td>Garlic, minced</td>
<td>15 grams</td>
</tr>
<tr>
<td>Sage leaves, chopped</td>
<td>1 gram</td>
</tr>
</tbody>
</table>

2. The recipe for “Fresh Tomato Salsa” (taken from Techniques of Healthy Cooking, page 225) is given in metric units. Convert this recipe to pounds and ounces.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>U.S. Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato concassê</td>
<td>400 grams</td>
</tr>
<tr>
<td>Jalapeño pepper, minced</td>
<td>30 grams</td>
</tr>
<tr>
<td>Red onion, minced</td>
<td>80 grams</td>
</tr>
<tr>
<td>Cilantro, fresh, chopped</td>
<td>15 grams</td>
</tr>
<tr>
<td>Lime juice, fresh</td>
<td>15 milliliters</td>
</tr>
</tbody>
</table>

3. The Fresh Tomato Salsa in problem #2 makes a good accompaniment to a variety of Southwestern or Tex/Mex dishes. It is also excellent when served with grilled fish, meats or poultry. If a typical portion is about 2 ounces, what is the yield for the above recipe?

4. A recipe for Chicken Scallopini with Mushrooms and Capers (also from our favorite cookbook, Techniques of Healthy Cooking, page 348) is given in U.S. units. Convert this recipe to metric units.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>U.S. Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken breast, boneless, skinless</td>
<td>2⅓ pounds</td>
</tr>
<tr>
<td>Butter, unsalted</td>
<td>2⅓ ounces</td>
</tr>
</tbody>
</table>
2¾ ounces Flour
1 pound, 4 ounces Mushrooms, sliced
4 ounces Capers, drained, rinsed
8 fluid ounces Sherry
26 fluid ounces Fond de Veau Lié
2¾ pounds Zucchini noodles

5. Praliné is frequently used to flavor fillings and ice creams. The ingredients used in a recipe for “Praliné” from Mastering the Art of French Pastry, page 414, are given below. Convert to metric units of weight. How many grams of Praliné will this recipe yield?

6 ounces Raw almonds
6 ounces Hazelnuts
1 cup Sugar
1½ cups Confectioners sugar

6. a. The following ingredients are for “Dessert Crepes” from Desserts and Beverages, page 239. Convert the recipe to metric units.
   b. One crepe takes about 36 grams of batter. What is the recipe yield?

2 Eggs
2 Egg Yolks
1 C Flour
¼ tsp Salt
1¼ C Milk
1 tsp Orange Rind, grated
1 tsp Cointreau Liqueur
1 Tbsp Butter or Margarine, melted

7. This recipe is for “Preserved Mango Chutney” from Techniques of Healthy Cooking, page 229. Find the food cost for this recipe.

1 kg Mango, fresh, diced 12 count per case (11 lb) at $7.45 per case
200 g Brown sugar 50-lb bag for $25.03
170 g Onion, diced (yellow) 50-lb bag for $5.40
140 g Raisins (golden) 30-lb case for $25 (92% yield)
30 g Walnuts, chopped (halves & pieces) 30-lb box for $85.74
10 grams Garlic, minced (peeled) $8.85 for 5 lbs
30 ml Cider vinegar 1 gal for $6.52
1 Lemon, juice and zest 140 for $32.30
15 g Ginger, minced 15-oz jar for $10.46
15 g Jalapeño pepper, minced (whole) $1.15 per lb (100% yield)
750 mg Mace, ground 16-oz jar for $11.85
500 mg Cloves, ground 16-oz jar for $15.58

8. In example 3, we converted the ingredient for “Sautéed Sole with Preserved Mango Chutney and Grilled Bananas” from metric units to U.S. units. Below are listed again the results of our conversions. Also listed are the costs of the ingredients.
a. Find the food cost per portion if the recipe yield is 8 portions.
b. If the food cost percent is 62%, what is the selling cost for one portion.
c. What is the mark-up rate?

2.2 pounds Sole fillets, trimmed $3.38 per lb (80% yield)
1.4 fluid ounces Skim milk 1 gal for $2.47
1 ounce Bread crumbs, dry (Panko crumbs) $.98 per lb
½ tsp Butter, whole, unsalted 1 case (55.11 lb) for $79.90
1 pound Preserved Mango Chutney see problem #7 above
1½ pounds Bananas, sliced on bias, grilled $.65 per lb (66.3% yield)

9. This recipe is for “Oatmeal Cookies” from Techniques of Healthy Cooking, page 550. One cookie takes 30 grams of the batter. If the mark-up rate is 200%, what is the selling price for one dozen cookies?

14 oz Sugar, brown 50-lb bag for $25.03
120 g Honey 7.5-lb jug for $12.35
15 g Butter, unsalted 1 case (55.11 lb) for $79.90
30 g Egg whites (frozen) 1 carton (5 lb) for $5.07
15 ml Evaporated skimmed milk 12-oz can for $.91
5 ml Vanilla extract *(dark, imitation) 1 gal (8 lb) for $16.14
140 g Oats, quick cooking 50-lb bag for $16
115 g Flour, all purpose 50-lb bag for $9.08
100 g dried pears, small diced 25-lb case for $38.88

* Pure vanilla extract is 1 gal (9 lb) for #113.89. Use imitation vanilla extract here!

10. The recipe for “Chocolate Polenta Soufflé” is in the Techniques of Healthy Cooking, page 530. Each soufflé is dusted lightly with powdered sugar and served with a sauce made by flavoring the dairy base with an appropriate liqueur or cordial. Say the cost of the powdered sugar and sauce are $.67 per soufflé. Below are the ingredients and costs. The recipe yields 10 portions. What is the selling price for one portion if the mark-up rate is 65%?

20 fl. oz Skim milk 1 gal for $2.47
1 oz Orange peel 1 lb for $.55
4 oz Sugar, granulated (Baker’s) 50-lb for $22.98
3 oz Cornmeal 25-lb bag for $10.73
1 oz Cocoa powder (Dutch) 50-lb bag for $86.25
1 3/4 oz Grated baking chocolate (Semi-sweet) 55-lb bar for $192.50
6 Egg whites (frozen) 1 carton (5 lb) for $5.07
(say 2 tbsp = 1 egg white)