Chapter 2

Weights & Measures

People use weights and measures all the time. Whether you are stepping onto the bathroom scale in the morning, buying a pound of meat from the deli, measuring a cup of milk when cooking dinner, hanging curtains in the bathroom, or sizing the font on your computer screen, you are using weights and measures.

This lab activity will review and fine tune your skills so you are better prepared to understand the concepts of weights and measures in the kitchen. Just a few examples of how weights and measures are applicable to your future profession and/or daily life include recipe preparation, portion sizing of foods, and understanding food labels. These weights and measures skills can provide a foundation for more advanced scientific and mathematics applications such as computing calories in foods, converting recipes from four servings to twenty-five, or balancing a chemical equation.

THINK ABOUT IT

- List some other applications for weights and measures that were not listed in the introduction.

- List 3 things you would like to learn about weights and measures or 3 questions you have relating to weights and measures.

  1.

  2.

  3.

LAB ASSIGNMENT:

Chocolate Chip Cookies

The purpose of this lab is to become familiar with kitchen equipment and to practice and review concepts of weights and measures. In this experience, you will use various ingredients to experiment with weights and measures. At the end of this exploration, you will apply your measurement skills to prepare chocolate chip cookies.

Overview:

All students will complete the weights and measures experiments using the ingredients needed to make chocolate chip cookies. Students will use their assigned fat (butter, margarine, or shortening) and assigned method (drop, pan-cooking, or slice-and-bake) to prepare chocolate chip cookies using some of the ingredients from the weights and measure experiment.

Kitchen 1: Chocolate chip cookies: Butter, Drop method

Kitchen 2: Chocolate chip cookies: Butter, Pan-cooking method

Kitchen 3: Chocolate chip cookies: Butter, Slice-and-bake method
(Prepare dough first then complete measurement experiments)

Kitchen 4: Chocolate chip cookies: Margarine, Drop method

Kitchen 5: Chocolate chip cookies: Margarine, Pan-cooking method

Kitchen 6: Chocolate chip cookies: Margarine, Slice-and-bake method
(Prepare dough first then complete measurement experiments)

Kitchen 7: Chocolate chip cookies: Shortening, Drop method

Kitchen 8: Chocolate chip cookies: Shortening, Pan-cooking method

Evaluation Tool:

- Evaluation of Chocolate Chip Cookies Table

Directions:

1. Always begin by washing your hands and thoroughly cleaning/sanitizing work surfaces.
2. Gather ingredients needed for the experiments and the assigned cookie recipe. Make sure all of your equipment is clean and ready to use.
3. Read "Tare Weight."
4. Complete all measurement experiments exploring the weights and measures of selected ingredients in chocolate chip cookies. Then, prepare the chocolate chip cookie recipe according to your assigned method and solid fat. *Note: Kitchens preparing cookies using the slice-and-bake method should prepare the dough first, then complete the measurement experiments.*
5. While the cookies are baking, complete the "Weights & Measures Questions." Be sure to read "Weights & Measures Science" and "Weights & Measures Tips for Consumers."
6. When all the cookies are finished, taste a sample of each and complete the evaluation tool. Clean your work station and check out before leaving.

Tare Weight:

To weigh your various ingredients, you will want to **tare** the scale. "Tare" is a term that is used in weights and measures to refer to the weight of an empty container. The tare weight (weight of the empty container) can be subtracted from the weight of the full container to determine the weight of the contents alone. The weight of the contents can also be measured by placing the container on the scale and then setting the scale to zero before filling the container (this is "taring the scale").

EXPERIMENTS & RECIPES:

Chocolate Chip Cookies

Measuring Flour Experiment

Ingredients:

1 small bag all-purpose flour

Method:

Let's experiment with measuring flour. You will try four different methods to measure 1-cup of flour. Make sure to subtract the weight of the empty measuring cup or tare the scale to zero. Record your results in the table below.

1. Dipped:
    a. Dip the 1-cup dry measuring cup directly into the container of flour, filling it to overflowing with flour.
    b. Level with the flat edge of a spatula and weigh.
    c. Record its weight in the table. (You may use this flour for step 2.)
2. Sifted directly into the dry measuring cup:
    a. Pour about 1 cup of flour into a sifter.
    b. Sift flour directly into the 1-cup dry measuring cup.
    c. Level with the flat edge of a spatula and weigh.
    d. Record its weight in the table.
3. Sifted then spooned into the cup:
    a. Pour about 1 cup of flour into a sifter.
    b. Sift onto wax paper.
    c. Spoon flour gently into the 1-cup dry measuring cup. Level with the flat edge of a spatula and weigh.
    d. Record its weight in the table.

4. Stirred then spooned into the cup:
   a. Stir flour in a bin or a bag with a spoon.
   b. Spoon flour gently into a 1-cup dry measuring cup. Level with the flat edge of a spatula and weigh.
   c. Record its weight in the table.

Flour Method	Weight (in grams) of 1 cup of flour
Dipped	g
Sifted directly	g
Sifted, spooned	g
Stirred, spooned	g

5. Discuss your observations and decide which technique you should use when measuring the flour for your chocolate chip cookies.

Measuring Sugar Experiment

Ingredients:

1 small bag granulated sugar

1 small bag brown sugar

Method:

Let's experiment with measuring sugar. You will try three different methods to measure 3/4-cup of sugar. Make sure to subtract the weight of the empty measuring cup or tare the scale. Record your results in the table. (If you do not have a 3/4 cup dry measure, use a 1/2 cup and a 1/4 cup.)

Sugar Method	Weight (in grams) of 3/4 cup sugar
Granulated	g
Brown, not packed	g
Brown, packed	g

1. Granulated sugar:
   a. Spoon sugar into a 3/4-cup dry measuring cup.
   b. Level with the flat edge of a spatula and weigh.
   c. Record its weight in the table. Set the measured granulated sugar aside to use in your cookie recipe.
2. Brown sugar not packed:
   a. Spoon brown sugar gently into the 3/4-cup dry measuring cup. Do not pack.
   b. Level with the flat edge of a spatula and weigh.
   c. Record its weight in the table.
3. Brown sugar packed:
   a. Spoon brown sugar into the 3/4-cup dry measuring cup.
   b. Press down with rubber spatula.
   c. Repeat steps 1 and 2 until the measuring cup is filled and level with edge of spatula.
   d. The sugar should hold the shape of the cup.
   e. Record its weight in the table. Set the packed brown sugar aside to use in your cookie recipe.
4. Discuss your observations.

Solid Fat Experiment

Ingredients:

2 cups softened solid fat, as assigned

1 teaspoon vanilla extract

Method:

Let's experiment with measuring solid fats. You will try two different methods to measure your 1-cup of butter, margarine, or shortening, as assigned. Record your results in the table.

Solid Fat Method	Weight (in grams) of 1 cup of fat
Solid, fractional	g
Solid, water displacement	g

1. Solid fat, fractional measure:
   a. Spray a 1-cup dry measuring cup with nonstick cooking spray. This will make it easier to remove the solid fat from the cup.
   b. Place the cup on the scale and tare the scale (or record the weight of the cup and subtract this weight from the weight to be measured in step e).
   c. Spoon your assigned solid fat into the 1-cup dry measuring cup.
   d. Pack into the cup, letting air escape.
   e. Level with the flat edge of a spatula and weigh.
   f. Record its weight in the table.
   g. Empty the cup using a rubber scraper and set the measured 1 cup of solid fat aside for use in your cookie recipe.
2. Solid fat, water displacement:
   a. Fill a 2-cup liquid measuring cup with 1 cup of cold tap water. Be sure to place the measuring cup on a flat surface and read the volume at eye level.
   b. Measure 1 cup of fat by spooning the fat into the liquid measuring cup until the water level reaches the 2-cup mark when read from eye level.
   c. Drain off the water.
   d. Place wax paper on the scale and weigh the fat.
   e. Record its weight in the table.
3. Discuss your observations, why cold water is specified, and the advantages/disadvantages of each method. Be sure to compare your answers with those using different solid fats.

Measuring Eggs Experiment

Ingredients:

2 large eggs

Method:

Let's experiment with measuring eggs. You will measure the weight of a large egg and test how many tablespoons are equal to the volume of a large egg. Make sure to subtract the weight of the empty measuring cup or tare the scale. Record your results in the table.

Egg Method	Measurement of 1 egg
Weight	oz.
Tablespoons	Tbsp.

1. Before handling raw eggs, let's review food safety tips relating to eggs:
   - If an egg is left at room temperature for more than 4 hours, the egg should be thrown away and not used.
   - A cracked egg and/or pink or iridescent white-colored egg white (spoiled egg) should be thrown away and not used.
   - Make sure to wash your hands before and after handling raw eggs.
   - Cooking utensils used to measure raw eggs should be thoroughly washed before re-use.
   - Batter or dough containing raw eggs should never be eaten.
2. Before beginning, let's review how to crack an egg. Always crack an egg into a separate small bowl. This allows you to examine the egg and make sure its appearance and smell are okay before adding it to other ingredients. For example, make sure the egg white is cloudy white or clear and that no eggshell pieces have fallen into the bowl. To crack the egg, hold it over the small bowl and tap it gently with a table knife or spatula until there is a dent (not a crack). Put your thumbs in opposite sides of the dent and gently pull the shell apart. The inside of the egg should drop into the small bowl.
3. Egg weight:
   a. Place a small bowl on the scale and tare the scale.
   b. Crack one egg into the bowl, examine it to make sure it looks okay, and then weigh it on the kitchen scale.
   c. Record the egg weight in ounces (oz) in the table and set the egg aside to use in your cookie recipe.

4. Egg tablespoons:
    a. Crack a second egg into a second small bowl. Examine it and then stir it with a fork to mix the white and yolk.
    b. Dip the tablespoon measure into the egg mixture and add one tablespoon at a time to the first bowl. Count the number of tablespoons and record them in the table. Set the eggs aside for the cookie recipe and discuss your observations.

Chocolate Chip Cookies

Ingredients:

2 ¼ cups flour, all-purpose
1 teaspoon salt
3/4 cup brown sugar, packed
2 large eggs
1 cup semi-sweet chocolate morsels (chips)
1 teaspoon baking soda
3/4 cup sugar
1 cup (2 sticks) solid fat, as assigned
1 teaspoon vanilla extract

Method:

1. Preheat the oven to 350° Fahrenheit. (Except for the slice-and-bake kitchens – see below).
2. Add the flour, baking soda, and salt to a medium bowl. Stir well.
3. In a large bowl, cream together the sugar, brown sugar, and solid fat using an electric mixer.
4. Continue mixing while gradually adding the eggs and the vanilla.
5. Add the flour, baking soda, and salt mixture and mix well.
6. Stir in 1 cup of chocolate chip morsels.
7. Prepare cookies to be baked according to your assigned method.

Drop Method:

- Drop by rounded tablespoon onto ungreased baking sheets.
- Bake for 9 to 11 minutes or until golden brown. Cool on baking sheets for 2 minutes; move to wire racks to cool completely. Makes about 5-dozen cookies.

Pan-Cooking Method:

- Grease a 15x10-inch jelly-roll pan. Spread dough into prepared pan.
- Bake for 20 to 25 minutes or until golden brown. Cool in pan, on a wire rack. Cut into 4-dozen bars.

Slice-and-Bake Method (Rolled or Refrigerator Method):

- Divide dough in half and wrap each half in waxed paper. Refrigerate for 1 hour or until firm. (Note: Dough may be stored in a refrigerator for up to 1 week or in a freezer for up to 8 weeks.)
- Preheat oven to 350° Fahrenheit.
- Cut logs into 1/2-inch-thick slices; place on ungreased baking sheets. Bake for 8 to 10 minutes or until golden brown. Cool on baking sheets for 2 minutes; move to wire racks to cool completely. Makes about 5 dozen cookies.

EVALUATION OF CHOCOLATE CHIP COOKIES

1. Taste each variation and place the numerical score for each characteristic in the upper left hand corner of each box. (Score System: 1=very poor; 2=poor; 3=fair; 4=medium; 5=good; 6=very good; 7=excellent)
2. Provide comments/descriptions to justify each numerical score.

QUALITY CHARACTERISTICS	APPEARANCE	CONSISTENCY/ TEXTURE	TENDERNESS	FLAVOR	OVERALL QUALITY
BUTTER, DROP METHOD					
BUTTER, PAN-COOKING METHOD					
BUTTER, SLICE-AND-BAKE METHOD					
MARGARINE, DROP METHOD					
MARGARINE, PAN-COOKING METHOD					
MARGARINE, SLICE-AND-BAKE METHOD					
SHORTENING, DROP METHOD					
SHORTENING, PAN-COOKING METHOD					

LEARN MORE:

Weights & Measures Science

◆ Be sure to measure ounces of dry ingredients using a scale, not a liquid measuring cup. Do not confuse ounces by weight with fluid ounces (volume); they are not the same.

Liquid Measuring Cup
Fluid Ounces (Volume)

Dry Ingredient Scale
Dry Ounces (Weight)

◆ You may find several measurement descriptors connected to dry ingredients in recipes. These definitions will help you accurately follow the measurement instructions:

- *Firmly Packed* means to tightly press the ingredient into the measuring cup.
- *Loosely Packed* means to press the ingredients into the measuring cup only enough to eliminate air pockets.
- *Level* means to scrape the ingredients off the top so the ingredients are level with the top of the measuring cup. Use the back edge of a straight knife or spatula to do this.
- *Rounded* means to pile the ingredients into the measuring cup without leveling. The shape will be softly rounded above the cup.
- *Heaping* means to pile as much of the ingredient into the measuring cup as it will hold, generally more than "rounded."

- *Sift* means to run the ingredient through a sifter or fine strainer to aerate it and eliminate lumps. Pay attention to how the recipe phrases this: *Measurement, sifted* means to measure the ingredient first, then sift it. (Example: 1 cup of flour, sifted). *Sifted measurement* means to sift first, then measure. (Example: 1 cup of sifted flour).

- Weights and measures abbreviations, volume equivalents, and mass equivalents are shown in the tables below.

Common Abbreviations
teaspoon = tsp or t
tablespoon = Tbsp or T
cup = c
pint = pt
quart = qt
gallon = gal
fluid ounce = fl oz
ounce = oz
pound = lb or #
gram = g
Milliliter = mL
Liter = L

Weight Equivalents
1 oz = 28.30 g
16 oz = 1 lb
1 lb = 453.6 g

Volume Equivalents
1 fl oz = 2 Tbsp
8 fl oz = 1 cup
1 pinch or dash = 1/8 tsp or less
3 tsp = 1 Tbsp
1/4 cup = 4 Tbsp
1/3 cup = 5 Tbsp + 1 tsp
1/2 cup = 8 Tbsp
2/3 cup = 10 Tbsp + 2 tsp
3/4 cup = 12 Tbsp
1 cup = 16 Tbsp
2 cups = 1 pt
2 pt = 1 qt
4 qt = 1 gal
1 tsp = 5 mL
1 cup = 0.24 L

- To convert an ingredient's weight from one unit to another, a **conversion factor** will be needed. It may come from the equivalents on previous tables. Multiply the weight in current units by the appropriate conversion factor to cancel out the original units (the chosen conversion factor will have the new unit on top and the original unit on bottom).

  Example: A recipe calls for 115 grams of flour, but the kitchen scale only measures weight in pounds and ounces. You need to know how many ounces are equal to 115 grams.

  The original unit is grams and our new unit is ounces. Therefore the conversion factor will be:

$$\frac{1\text{ oz}}{28.30\text{ g}}$$

  Original units weight x conversion factor = new units weight

$$115\text{ g} \times \frac{1\text{ oz}}{28.30\text{ g}} = \frac{115\text{ oz}}{28.30} = 4.06\text{ oz.}$$

- If the conversion factor isn't perfect, multiple steps or multiple conversion factors may be needed to get to the correct units.

  Example: A soup recipe calls for 1 quart of water, but there is only a volume measure that measures in liters. Find how many liters are equal to 1 quart. The table above shows that there are 2 pints in a quart, 2 cups in a pint, and 0.24 liters in a cup. Use three conversion factors to solve this problem.

$$1\text{ qt} \times \frac{2\text{ pt}}{1\text{ qt}} \times \frac{2\text{ c}}{1\text{ pt}} \times \frac{0.24\text{ L}}{1\text{ c}} = 0.96\text{ L}$$

Weights & Measures Tips for Consumers

◆ Follow these tips for best results when measuring liquid ingredients:

- Use small liquid measuring cups to measure small volumes and large liquid measuring cups to measure large volumes. For instance, use a 1-cup measuring cup instead of a 4-cup measuring cup when the recipe calls for 2/3 cup of milk.
- When pouring a liquid into a liquid measuring cup, set the cup on a flat, solid surface (such as the countertop) and bend down to read the measurement at eye level.
- When measuring small amounts of liquids with tablespoons or teaspoons, hold the spoon over an empty bowl instead of your ingredient bowl. It's easy to over-pour and ruin your dish or batter by adding two teaspoons of almond extract instead of one!

◆ Weights and measures can be used to help make best-buy choices in the grocery store. The largest package is not always the best buy. Listed unit prices display the cost per "unit," such as the cost per pound or the cost per ounce. As long as the comparison is between similar quality products on the same "per unit" basis, the cost per "unit" makes a best-buy purchasing decision easy! Many grocery stores mark items with an item price as well as unit price. If two products have different "units" for "cost per unit," compute a comparable unit price by dividing the item price by a number of common units.

Example: Crackers are sold in 3 different sized packages. The number of ounces in each package is known, making the computing of a comparable unit price by dividing the cost per package by the number of ounces in each package easy:

14 oz package for $3.50 : 3.50 / 14 = $0.25 per ounce
20 oz package for $3.80 : 3.80 / 20 = $0.19 per ounce
32 oz package for $6.72 : 6.72 / 32 = $0.21 per ounce

- When comparing something more complicated, such as boneless chicken breast costing $3.00/lb or bone-in chicken breast costing $2.25/lb, it can be more challenging. The bone-in costs less per pound, but the bone included in the price is waste! To calculate the better buy, the yield of the **"as purchased" product** (AP – in this example, the bone-in breast) should be found — that is, how much **"edible product"** (EP — in this case, boneless breast) will be left in the end. Once the yield is found, compare costs using the following formula:

$$\text{EP cost/lb} = \frac{\text{AP cost per lb}}{\text{Yield \%}}$$

  Experiments have shown that the average yield of bone-in chicken breast is 70%. That is, one pound of bone-in will normally yield 0.7 lb of edible meat. To find out the cost of the edible meat in this example (paying $2.25/lb for bone-in chicken breast), plug the yield % and given AP cost into the formula:

$$\text{EP cost/lb} = \frac{\$2.25}{0.70} = \$3.21$$

  In this case, the edible portion of the bone-in chicken breast costs $3.21/lb, versus $3.00/lb to buy the boneless in the first place.

- The formula above does not do much good if the yield is not known. There are many books available that provide great detail about **food yields.** The yield for many meats, vegetables, nuts, and other products can be found online.

Weights & Measures Questions

1. If a recipe calls for 2 cups sifted flour, when should you sift the flour and why is it important to actually sift the flour?

2. Your recipe calls for 7 ounces of granulated sugar, but your kitchen scale only measures weight in grams. How many grams of granulated sugar will you need to measure to equal 7 ounces? (Show your work.)

3. Your recipe calls for 3 tablespoons of milk, but you are planning to quadruple your recipe and will truly need 12 tablespoons. You decide it may be easier to convert the tablespoons to cups than to measure 12 tablespoons. How many cups of milk will you need? (Show your work.)

4. At your local grocery store you can buy seedless, chunked watermelon for $0.99/lb or a 10 lb whole watermelon for $3.70 (AP = $0.37/lb). The yield of watermelon is 45%. Which is the better buy seedless, chunked watermelon or whole watermelon? (Show your work.)

5. When might you use the water displacement method to measure a solid fat?

6. If you are making one large batch (several times the recipe) of cookies for a bake sale at school, would you want to weigh your ingredients or use household measuring cups? Why?

7. Which chocolate chip cookie did you prefer (be sure to state the method and solid fat used)? Why? (Answer after completing the taste test.)

Weights & Measures Teacher Tips

Overview

- This lab should not be skipped and takes about 2 hours to complete. This lab teaches students the correct ways to measure dry and liquid ingredients.
- The food safety laboratory experiment using thermometers can be done as part of this laboratory.
- This lab may be the first one and include the orientation to the lab as well as sensory evaluation methods to be used throughout the course.
- The experiments used in this laboratory demonstrate the importance of weights and measures and how the proportions of ingredients can impact a product. It also demonstrates how different fats can affect the flavor and texture of a product.

Lab Management

Demonstrations

- Demonstrate the proper way to tare a scale.
- Demonstrate the difference in products made "from scratch" versus mass-produced. For example, compare the appearance and texture of a homemade or a fine bakery-made croissant with a croissant purchased from a fast food restaurant.
- Review with students, prior to beginning the lab, the differences between dry and liquid measuring cups (demonstrate both kinds) and when they should use a scale.

Time Management

- Kitchens should pre-heat their ovens while they are doing their experiments.
- Allow at least 2 hours for the lab and help students stay on track by having them read their experiment before coming into lab.

Sensory Evaluation

- Introduce the topic of sensory evaluation. Give students an overall orientation to sensory evaluation as it will be done in your facility.

◆ Since students are increasingly accustomed to processed foods, they may not share the traditional standards/criteria to rate a product. Take time to discuss sensory evaluation with the students.

You may want to discuss:

a. Brownness of crusts of breads and pies.
b. Lightness of breads and cakes.
c. The pleasure color gives and how it is associated with index of quality and doneness.
d. How odor gives pleasure or displeasure, and is an index of quality or wholesomeness.
e. Mouth feel or the way food feels in the mouth. Use as an example: Mountain Dew has the food additive, brominated vegetable oil, which is known to give its classic mouth feel.

◆ You may choose, on days when there is both time and a large volume of product, to invite others in your program or building to participate in a taste panel. Review with students the basics of evaluation by a taste panel. Ensure the panelists know what is expected of them.

- For example, a pastry might be judged on appearance and eating quality. The experts would give the most points to a crust that has a uniform brown crust and attractive finished edges; that is medium-thin and crisp; that is tender and flaky; and has a bland flavor.

Experiment Tips

- Commercial Grade Gas Ranges:
  - » Note that most recipes used in this laboratory manual were designed for consumer and consumer equipment. If you are using a commercial kitchen with commercial grade equipment, you may need to alter some preparation times. For example, you may need to reduce the oven temperature by 25˚F compared to a conventional oven.
- Measuring Flour Experiment:
  - » Sifted flour from step 2 can be added to a separate medium size bowl and used for the cookie recipe. Flour from step 3 can be resifted, like in step 2, and added to the same bowl for the recipe. An extra ¼ cup of flour will need to be sifted and added to the bowl in order to have enough flour for the cookies. Doing this will prevent food waste and free measuring cups for later use.
- Measuring Sugar Experiment:
  - » After the brown sugar is weighed in step 2, pack it and continue with step 3.
  - » Add both sugars to a different large bowl.

- Measuring Solid Fat Experiment:
  - » Remind students to carefully read packaging when selecting their solid fat from the refrigerator. Groups cooking with the wrong fat will result in incorrect sensory evaluations and missing ingredients for other kitchens.
  - » Take the butter out prior to the lab to allow it to start softening.
  - » Add butter to the bowl with the sugar to free a measuring cup for later use.

Nutrition Points for Discussion:

◆ The weights and measures component of this lab uses a chocolate chip cookie. Ask the students what type of cookie they might substitute for the chocolate chip. What is the nutrient profile of a chocolate chip cookie?

SHOPPING LIST: (8 SECTIONS)

Item	Utilized Unit/Lab Section	Purchased Unit
Cooking Spray	_	2 cans
Flour	6-8 lbs	(2) 5 lb bags
Granulated Sugar	6 cups	5 lb bag
Brown Sugar	6 cups	(2) 5 lb bags
Crisco	4 cups	1 can
Margarine	6 cups	3 boxes (sticks)
Butter	6 cups	(3) 1 lb blocks
Vanilla	8 tsp	1 lg. bottle
Eggs	16	2 cartons
Baking Soda	3 TBSP	1 box
Salt	8 tsp	1 box
Semi-Sweet Chocolate Morsels	96 oz	(8) 12 oz. bags