Chapter 1: Weights & Measures

MASS MEASUREMENTS

Being able to make accurate and precise measurements is a skill needed in daily life, as well as in the science lab. For example, bakers and chefs must know the most accurate way to measure each ingredient to make the best tasting product. Depending on the state of matter (solid or liquid) a different measurement tool may be needed. Using the tool properly also affects the accuracy and precision of the measurements made. In this chapter, students will explore the proper use of measurement tools and investigate measurements used on Nutrition Facts Labels.

FOOD EXPLORATION LABS

Lab I: Mastering Measurements

- Teacher Preparation
- Teacher Lab Answer Key
- Student Lab

Lab II: Label Logic

- Teacher Preparation
- Teacher Lab Answer Key
- Student Lab

INVESTIGATING YOUR HEALTH

Everyday Weighing and Measuring

- Teacher Answer Key

Try This At Home: Oatmeal-Flax Chocolate Chip Cookies

SUPPLEMENTAL MATERIALS

Lab I: Mastering Measurements

- Teacher Preparation Slides
- Student Demonstration Slides & Video
- Weight & Measurement Chart

Lab II: Label Logic

- Teacher Preparation Slides
- Student Demonstration Slides & Video
- Common Household Measurement Tools Chart

LESSON PLAN

Food Explorations Lab I:
Mastering Measurements

TEACHER LESSON PREPARATION

Lesson Focus

Understand precision of measurement and factors that can impact accuracy. Determine relative densities of the measured substances.

Lesson Description

Students will use common household measurement tools and scientific measurement tools to determine volumes and masses of flour, cooking oil, and water. Different measurement methods (sift, spoon, and dipped) will be used to obtain flour samples and the masses will be compared for accuracy. The precision of different measurement tools for volume will be demonstrated using cooking oil and water. Students will calculate percent error by comparing their measurements to actual values. They will also compare the masses of equal volumes of the substances to determine their relative densities.

Academic Content Standards

ELA Common Core Standards for Literacy in Science and Technical Subjects (R-reading, W-writing, SL-speaking and listening, L-language) Grades 6-8

R-1 Cite specific textural evidence to support analysis of science and technical texts.

R-3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

R-4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical content relevant to grade (6-8) text and topics.

R-7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph or table).

R-10 Read and comprehend complex science/technical texts independently and proficiently.

W-2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

W-9 Draw evidence from informational texts to support analysis, reflection, and research.

SL-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade (6-8) topics, texts, and issues, building on others' ideas and expressing their own clearly.

L-1 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Next Generation Science Standards

Performance Expectations

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Disciplinary Core Ideas

PS1.A Structure and Properties of Matter: Each substance has characteristic physical and chemical properties that can be used to identify it.

Science and Engineering Practices

Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in the findings.

Background Information

It is important to use the correct measurement tools when preparing food. **Dry measurement** cups measure volume and should be used to measure dry ingredients only. You should use these tools when a recipe calls for amounts of dry ingredients in cups, etc. If a recipe calls for dry ingredients by weight (e.g. ounces), you should use a scale to measure the ingredients. You should also make sure to follow instructions carefully because some items need to be sifted, spooned, packed, or dipped. **Liquid measurement** tools measure volume and should only be used when a recipe calls for liquids to be measured in cups, etc.

Liquid Measuring Cup
(Cups and Fluid Ounces)

Dry Measuring Cups
(1 cup, ¾ cup, ½ cup, ¼ cup)

Graduated Cylinder
(mL)

Proper Measurement Methods for Flour

Spooned Method

Dipped Method

Sifted Method

Spoon: Stir flour in a small bowl or bag with a spoon. Spoon flour gently into a dry measuring cup. Level with the flat edge of a plastic knife over wax paper.

Dipped: Dip the dry measuring cup directly into the container of flour, filling it to overflowing with flour. Level with the flat edge of a plastic knife over wax paper.

Sift: Pour the flour into a strainer. Sift onto wax paper by shaking the flour through the strainer. Spoon flour gently into a dry measuring cup. Level with the flat edge of a plastic knife over wax paper.

Tip: View the "how to" video lab demonstration (Weights & Measures Lab I Demonstration Video) to see a visual demonstration of the described flour measurement methods.

Proper Measurement Methods for Liquids

Set the measuring cup on a level surface before pouring the liquid into the container. Allow any foam or bubbles that form after pouring to settle. Read the liquid measurement at the lowest point of the meniscus (curved upper surface of the liquid).

Conversions

Milligrams (mg) to grams (g): 1g=1,000 mg (Example: 1,600 mg = 1.6 grams; move the decimal place three places to the left).

Grams (g) to Kilograms (kg): 1kg=1,000 g (Example: 50 g = 0.05 kg; move the decimal place three places to the left)

Precision and Accuracy of Measurements

The **accuracy** of a measurement is how much that measurement differs from a known, true value. For example, if a "10g" brass mass from a standard set of masses is measured on a reliable scale and is found to be 10g, than the mass is accurate, but, if it is found to be 9.8g, it is not. Percent error can be calculated to determine the accuracy of a measurement. **Precision** is how reliable the measuring device is and how reproducible its measurements are. A 100-milliliter beaker is not as precise as a 100 milliliter graduated cylinder. One hundred milliliters measured in a beaker will vary slightly every time the beaker is used. The graduated cylinder has more graduations and will be more precise.

Materials

Teacher Materials

NOTE: Teacher material list is based on 6 groups of 4-5 students (24-30 students total).

3 plastic bags containing 1 ½ cups all-purpose flour
3 plastic cups (10 oz. or greater) containing 1 cup water
3 plastic cups (10 oz. or greater) containing 1 cup cooking oil

Student Materials

NOTE: Student material list is based on 1 group of 4-5 students. Refer to the "Equipment and Material Lists by Chapter" on page XIV of the FoodMASTER Middle Teacher Edition for whole class estimates (24-30 students divided into 6 groups) for perishable and nonperishable materials.

Assignment A

1 ½ cups all-purpose flour in a plastic bag
1 set dry measuring cups
1 scale (triple beam balance or kitchen scale)
1-2 sheets wax paper
1 strainer (wide mesh)
1 medium bowl
1 plastic knife
1 plastic spoon

Assignment B

1-cup cooking oil in plastic cup (10 oz. or greater)
1-cup water in plastic cup (10 oz. or greater)
1 set dry measuring cups
1 liquid measuring cup (1 cup measure or greater)
1 graduated cylinder (100mL)
1 scale (triple beam balance or kitchen scale)

Teacher Pre-Lab Preparation

1. Review teacher background information, teacher preparation slides, student pre-lab slides/videos, student introduction, suggested instructional plan, and the student *Food Exploration* lab investigation procedures.

2. Prepare materials for each group. Assign 3 groups to Assignment A and 3 groups to Assignment B.

   NOTE: For 6 student groups, 3 groups will use flour and 3 groups will use liquids.

   A. Fill 1 plastic bag per student group with 1-½ cups of flour.

B. Fill 2 plastic cups with liquid ingredients (1 cup with water, 1 cup with cooking oil) per student group.

3. In the lab investigation, students will be measuring and massing ingredients, calculating percent error, and converting measurements. Consider reviewing with students how to tare a scale, how to properly measure dry and liquid ingredients, how to calculate percent error, and how to convert between common measurements (e.g. ounces to cups, cups to tablespoons).

Suggested Instructional Plan

1. Review scientific vocabulary and knowledge prerequisites:

Volume	**Mass/Weight**	**Gram**	**Ounces**
Cups	**Accuracy vs. Precision**	**Meniscus**	
Matter	**Density**	**Percent Error**	

2. Distribute Materials:

It is recommended that materials are organized into stations for easier distribution. Materials are recommended based on the amount needed for 1 class of 30 students. Students should be arranged in small groups of 4-5.

Each group should receive:

- Student Lab Investigation Worksheets (1 per student)
- Student Materials

3. Ask students to read *Mass Measurements* and complete the focus questions for this lab investigation.

4. Before beginning the lab investigation:

a. Require students to wash their hands.

b. Emphasize the importance of practicing good food safety behaviors by not consuming substances used as part of the lab investigation.

5. Launch the lab by asking students to make a prediction about accuracy of methods and precision of tools used when measuring ingredients. Show students the provided video lab demonstration *(Weights & Measures Lab I Demonstration Video).*

a. *Dry Ingredient (Flour):* The most accurate method for measuring flour is the sifted method. In cooking, it is recommended that flour be sifted before measuring. Flour tends to be a more difficult ingredient to measure due to its tendency to pack down, which increases the density of the ingredient.

b. *Liquid Ingredients (Cooking Oil & Water):* The oil and liquid should weigh approximately the same regardless of the tool used to measure them; however, students will observe a difference in the accuracy of measurement. The liquid measuring cup should allow students to observe and

measure the amount of liquid using the **meniscus**; however, that does not necessarily mean the measurement will be completely accurate. The dry measuring cup does not allow such accuracy when measuring liquids and is more prone to spilling (human error). Both of these common kitchen tools should prove to be the least accurate. Of the three tools, the graduated cylinder will be the most accurate. The graduated cylinder should have the most graduations allowing the observer to measure to the nearest milliliter. When comparing the two liquids, the relative density of cooking oil and water differ, resulting in different weights of each. Oil has a lower density compared to water, and therefore weighs less per unit volume.

6. Allow students to work in small groups on the Student Lab Investigation worksheet to further explore the topic and respond to lab questions.

7. Follow-up with a class discussion about the importance of accurate methods and tools in science. See *Teacher Bites* for ideas on how to further extend this lesson.

Teacher Bites: Lesson Extension

- Explore accuracy further using different methods and measurement tools (e.g. beaker).

LESSON PLAN

Food Explorations Lab II:
Label Logic

TEACHER LESSON PREPARATION

Lesson Focus

Understand how to read and interpret a Nutrition Facts label as a source of information for nutrient content in food products.

Lesson Description

Using the Nutrition Facts labels from two comparable potato chip products, students will calculate the mass of the macronutrients in three servings. Using food ingredients that represent the macronutrients, students will measure masses equal to the calculated amounts and then convert them to volume measurements using teaspoons (more commonly used in cooking). Students will also calculate the how each macronutrient contributes to the number of calories in the food products.

Academic Content Standards

ELA Common Core Standards for Literacy in Science and Technical Subjects (R-reading, W-writing, SL-speaking and listening, L-language) Grades 6-8

R-1 Cite specific textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

R-3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

R-4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical content relevant to grade (6-8) text and topics.

R-7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph or table).

R-10 Read and comprehend complex science/technical texts independently and proficiently.

W-2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

W-9 Draw evidence from informational texts to support analysis, reflection, and research.

SL-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade (6-8) topics, texts, and issues, building on others' ideas and expressing their own clearly.

L-1 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Next Generation Science Standards

Performance Expectations

MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Disciplinary Core Ideas

LS1.C Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, support growth, or release energy.

Science and Engineering Practices

Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in the findings.

Background Information

The Food and Drug Administration (FDA) regulates Food labels, also called Nutrition Facts labels. They were created to ensure consumers of safe products. Over time, they have evolved to provide consumers with measurement information about food. This information helps consumers make educated decisions related to health and wellness. Each label provides nutrient information for a serving size of that product. Serving sizes are not necessarily based on portion size, but rather a standardized amount of the product that can easily be divided into the whole. Most serving sizes are consistent with similar foods and are measured using household measurements. A serving size of milk, for example, is always measured by cup. All Nutrition Facts labels include calories, daily value, fat, cholesterol, sodium, carbohydrates, fiber, protein, certain vitamins and minerals, and an ingredients list. Percent daily value (%DV) is based on the total amount a person on a 2,000-calorie per day diet should consume. In 2016, the Nutrition Facts label was updated; updates include larger and bolded font for servings per container, updates to serving sizes, larger font for calories, updated daily values, change in nutrients required, added sugars now included, and a new footnote. This value is determined by dividing the amount in a serving of the product by the total amount recommended and multiplying it by 100 to express it as a percentage. The ingredients list includes all ingredients in the product listed from those of the greatest weight to those of the least weight. We should use Nutrition Facts labels to ensure we are consuming an adequate diet.

CALORIES
The total calories and calories from fat in one service.

NUTRIENTS
The metric amounts of fats, cholesterol, sodium, carbohydrate, fiber and protein in one label serving. Sometimes other nutrients are included.

VITAMINS & MINERALS
The % Daily Value of the vitamins and minerals.

Nutrition Facts

Serving size 1 cup (228g)
Servings Per Container 2

Amount Per Serving
Calories 250 Calories from fat 110

	% Daily Value*
Total Fat 12g	**18%**
Saturated Fat 3g	**15%**
Trans Fat 3g	
Cholesterol 30mg	**10%**
Sodium 470g	**20%**
Potassium 700mg	**20%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

*Nutrition Facts label information from *Food, Nutrition & Wellness* by Roberta Duyff, Woodland Hills, CA; Glencoe/ McGraw-Hill, 2010.

% DAILY VALUE
The percentage that one serving provides of the Daily Value for some nutrients. The % Daily Value also helps you judge how much of a nutrient a serving provides. In the 5-20 guide, 5 percent or elss is low; 20 percent or more is high.

% DAILY VALUES EXPLANATION
Daily Values are based on a 2,000-calorie diet. Your daily value may be higher or lower depending on your calorie needs.

Materials

Teacher Materials

NOTE: Teacher material list is based on 6 groups of 4-5 students (24-30 students total).

6 plastic cups containing salt
6 plastic cups containing sugar
6 plastic cups containing softened butter
6 plastic cups containing olive oil
30 plastic cups
1 black permanent marker

Student Materials

NOTE: Student material list is based on 1 group of 4-5 students. Refer to the "Equipment and Material Lists by Chapter" on page XIV of the FoodMASTER Middle Teacher Edition for whole class estimates (24-30 students divided into 6 groups) for perishable and nonperishable materials.

1 small cup of salt *(represents sodium)*
1 small cup of sugar *(represents carbohydrates)*
1 small cup of softened butter *(represents saturated fat)*
1 small cup of olive oil *(represents unsaturated fat)*
1 set of measuring spoons
1 scale (e.g. triple beam balance)
4 small empty cups

Teacher Pre-Lab Preparation

1. Review teacher background information, teacher preparation slides, student pre-lab slides/videos, student introduction, suggested instructional plan, and the student *Food Exploration* lab investigation procedures.

2. Prepare materials for each group. Pre-label cups for each student group. Label each cup with an ingredient name (i.e. salt, sugar, butter, and olive oil). Each ingredient should have two labeled cups (one filled, one empty).

3. Fill each cup approximately 1/4 full with salt, sugar, butter, and olive oil.

TIMESAVER: If time is a concern, student groups may be assigned one of the macronutrients to measure. Groups can share their results.

LESSON PLAN

Suggested Instruction Plan

1. Review scientific vocabulary and knowledge prerequisites:

   Gram **Nutrition Facts label**

2. Consider having your students research the components included on a Nutrition Facts label prior to beginning the lab investigation (see *Investigating Your Health*).

3. Distribute Materials:

   It is recommended that materials are organized into stations for easier distribution. Materials are recommended based on the amount needed for 1 class of 30 students. Students should be arranged in small groups of 4-5.

   Each group should receive:

   - Student Lab Investigation Worksheets (1 per student)
   - Student materials

4. If applicable, ask students to read *Mass Measurements* and complete the focus questions for this lab investigation.

5. Before beginning the lab investigation:

   - Require students to wash their hands.
   - Emphasize the importance of practicing good food safety behaviors by not consuming substances used as part of the lab investigation.

6. Launch the lab by asking students to observe and make a prediction about which snack option has the best nutrition profile.

   a. *Snack #1 – Classic Potato Chips:* Students should find the classic potato chips have more calories, fat, and sodium.

   b. *Snack #2 – Baked Potato Chips:* Students should find the baked potato chips have fewer calories, grams of total fat, and sodium. The baked chips also contain more fiber. However, the baked chips do contain more sugar. Overall, due to the lower number of calories and fat grams and higher fiber content, baked chips are the better option.

7. Allow students to work in small groups on the Student Lab Investigation worksheet to further explore the topic and respond to lab questions.

8. Follow-up with a class discussion about reading Nutrition Facts labels to obtain health information about food. See *Teacher Bites* for ideas on how to further extend this lesson.

Teacher Bites: Lesson Extension

- Have students bring in labels of their favorite snacks to review as a class.

Investigating Your Health:
Everyday Weighing and Measuring

STUDENT HEALTH INVESTIGATION

Lesson Focus

Evaluate and compare foods by looking at the Nutrition Facts labels.

Lesson Description

Students will compare a Nutrition Facts label from their favorite snack to the Nutrition Facts label for pineapple chunks packed in 100% fruit juice. Calories from each nutrient will be calculated and students will be asked to support their choice of the healthiest snack option.

Academic Content Standards

ELA Common Core Standards for Literacy in Science and Technical Subjects (R-reading, W-writing, SL-speaking and listening, L-language) Grades 6-8

R-1 Cite specific textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

R-4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical content relevant to grade (6-8) text and topics.

R-7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph or table).

R-10 Read and comprehend complex science/technical texts independently and proficiently.

W-2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

W-7 Conduct short research projects to answer a question (including a self-generated question) drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

L-1 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Next Generation Science Standards

Performance Expectations

MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Disciplinary Core Ideas

Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, support growth, or release energy.

Science and Engineering Practices

Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in the findings.

Suggested Instructional Plan

1. Review Scientific Vocabulary and Knowledge Prerequisites:

   Nutrition Facts label

2. Instruct students to research the information listed on the Nutrition Facts panel prior to beginning the investigation.

3. Students can find food labels in the grocery store, USDA's nutrient database (http://ndb.nal.usda.gov/ndb/search/list), or use the labels provided.

4. If the student chooses to use the provided food label, see the Teacher Edition workbook for answers to the Investigating Your Health lab questions. Answers to questions based on other food labels will vary.

5. If completed in-class, allow students to work in small groups on the Investigation worksheet to further explore the topic and respond to questions.

6. Follow-up with a class discussion about student findings related to their favorite snacks and student generated ideas for choosing healthy snacks.

Snack Food Labels

Pepino's Pepperoni Pizza Rolls

Nutrition Facts

Serving Size	**6 rolls**
Calories	**210**
Total Fat	**10g**
Sodium	**420mg**
Total Carbohydrates	**24g**
Dietary Fiber	**1g**
Sugars	**2g**
Protein	**7g**

Vitamin A 0%	Vitamin C 0%
Vitamin E 0%	Calcium 2%
Iron 8%	Thiamin 0%
Niacin 0%	Folate 0%
Vitamin B_{12} 0%	Zinc 0%
Magnesium 0%	

Cool Corn Ranch Chips

Nutrition Facts

Serving Size	**1 oz**
Calories	**150**
Total Fat	**8g**
Sodium	**180mg**
Total Carbohydrates	**18g**
Dietary Fiber	**2g**
Sugars	**<1g**
Protein	**2g**

Vitamin A 0%	Vitamin C 0%
Vitamin E 6%	Calcium 2%
Iron 0%	Thiamin 4%
Niacin 0%	Folate 0%
Vitamin B_{12} 0%	Zinc 0%
Magnesium 4%	

String Cheese

Nutrition Facts

Serving Size	**1 piece**
Calories	**80**
Total Fat	**6g**
Sodium	**200mg**
Total Carbohydrates	**<1g**
Dietary Fiber	**0g**
Sugars	**0g**
Protein	**6g**

Vitamin A 4%	Vitamin C 0%
Vitamin E 0%	Calcium 20%
Iron 0%	Thiamin 0%
Niacin 0%	Folate 0%
Vitamin B_{12} 0%	Zinc 0%
Magnesium 0%	

Strawberry Yogurt

Nutrition Facts

Serving Size	**1 tube**
Calories	**70**
Total Fat	**0.5g**
Sodium	**30mg**
Total Carbohydrates	**13g**
Dietary Fiber	**0g**
Sugars	**10g**
Protein	**2g**

Vitamin A 8%	Vitamin C 0%
Vitamin E 0%	Calcium 10%
Iron 0%	Thiamin 0%
Niacin 0%	Folate 0%
Vitamin B_{12} 0%	Zinc 0%
Magnesium 0%	