Topic B

Measuring Weight and Liquid Volume in Metric Units

3.NBT.2, 3.MD.2, 3.NBT.8

Focus Standard:

3.NBT.2    Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

3.MD.2    Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Instructional Days: 6

Coherence -Links from:

G2–M2    Addition and Subtraction of Length Units
G2–M3    Place Value, Counting, and Comparison of Numbers to 1000
G3–M1    Properties of Multiplication and Division and Solving Problems with Units of 2–5 and 10

-Links to:

G4–M2    Unit Conversions and Problem Solving with Metric Measurement

Lessons 6 and 7 introduce students to metric weight measured in kilograms and grams. Students learn to use digital scales as they explore these weights. They begin by holding a kilogram weight to kinesthetically understand its feel. Then, groups of students work with scales to add rice to clear plastic zippered bags until the bags reach a weight of 1 kilogram. Once the bags are made, students decompose them using ten-frames. They understand the quantity within 1 square of the ten-frame as an estimation of 100 grams. Upon that square they overlay another ten-frame, “zooming in” to estimate 10 grams.Overlaying once more leads to 1 gram. Students relate the decomposition of a kilogram to place value and the base ten system.

Through this two-day exploration, students reason about the size and weight of kilograms and grams in relation to one another without moving into the abstract world of conversion. They perceive the relationship between kilograms and grams as analogous to a meter decomposed into 100 centimeters. Students build on Grade 2 estimation skills with centimeters and meters (2.MD.3) using metric weight. Students use scales to weigh a variety of objects and learn to estimate new weights using knowledge of previously measured items. Their work with estimation in Topic B lays a beginning foundation for rounding to estimate in the second half of the module.
In Lesson 8, students use scales to measure the weight of objects precisely, and then use those measurements to solve one-step word problems given in the same units. Word problems require students to add, subtract, multiply, and divide. Students apply estimation skills from Lesson 7 to reason about their solutions.

In Lessons 9 and 10, students measure liquid volume in liters using beakers and the vertical number line. This experience lends itself to previewsing the concept and language of rounding: students might estimate, for example, a given quantity as \textit{halfway} between 1 and 2, or \textit{nearer} to 2. Students use smaller containers to decompose 1 liter and reason about its size. This lays a conceptual foundation for Grade 4 work with milliliters and the multiplicative relationship of metric measurement units (\textbf{4.MD.1}). In these lessons, students solve one-step word problems given in the same units using all four operations.

Topic B culminates in solving one-step word problems given in the same units. Lesson 11 presents students with mixed practice adding, subtracting, multiplying, and dividing to find solutions to problems involving grams, kilograms, and liters.

### A Teaching Sequence Towards Mastery of Measuring Weight and Liquid Volume in Metric Units

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<th>Build and decompose a kilogram to reason about the size and weight of 1 kilogram, 100 grams, 10 grams, and 1 gram. (Lesson 6)</th>
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<td>Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures. (Lesson 7)</td>
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<td>Objective 3:</td>
<td>Solve one-step word problems involving metric weights within 100 and estimate to reason about solutions. (Lesson 8)</td>
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<td>Objective 4:</td>
<td>Decompose a liter to reason about the size of 1 liter, 100 milliliters, 10 milliliters, and 1 milliliter. (Lesson 9)</td>
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<td>Objective 5:</td>
<td>Estimate and measure liquid volume in liters and milliliters using the vertical number line. (Lesson 10)</td>
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<td>Objective 6:</td>
<td>Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units. (Lesson 11)</td>
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Lesson 6

Objective: Build and decompose a kilogram to reason about the size and weight of 1 kilogram, 100 grams, 10 grams, and 1 gram.

Suggested Lesson Structure

<table>
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<th>Activity</th>
<th>Duration</th>
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<tr>
<td>Fluency Practice</td>
<td>(3 minutes)</td>
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<tr>
<td>Concept Development</td>
<td>(47 minutes)</td>
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<tr>
<td>Student Debrief</td>
<td>(10 minutes)</td>
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<td><strong>Total Time</strong></td>
<td>(60 minutes)</td>
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Fluency Practice (3 minutes)

- Tell Time on the Clock 3.MD.1 (3 minutes)

Tell Time on the Clock (3 minutes)

Materials: (T) Analog clock for demonstration (S) Personal white boards

Note: This activity provides additional practice with the newly learned skill of telling time to the nearest minute.

T: (Show an analog demonstration clock.) Start at 12 and count by 5 minutes on the clock. (Move finger from 12 to 1, 2, 3, 4, etc., as students count.)

S: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60.

T: I’ll show a time on the clock. Write the time on your board. (Show 7:13.)

S: (Write 7:13.)

T: (Show 6:47.)

S: (Write 6:47.)

Repeat process, varying the hour and minute so that students read and write a variety of times to the nearest minute.
Lesson 6

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Lesson 6

Concept Development (47 minutes)

Materials: (T) 1 kilogram weight, 1-kilogram benchmark bag of beans (S) 1-kilogram benchmark bag of beans (one per pair of students), digital scale that measures in grams, pan balance, rice, gallon-sized sealable bags, and dry-erase marker

Part 1: Use a pan balance to make a bag of rice that weighs 1 kilogram.

T: Today we are going to explore a kilogram. It’s a unit used to measure weight. (Write the word kilogram on the board.) Whisper kilogram to a partner.

S: Kilogram.

T: (Pass out a 1-kilogram bag of beans to each pair of students.) You are holding 1 kilogram of beans. To record 1 kilogram, we abbreviate the word kilogram by writing kg. (Write 1 kg on the board.) Read this weight to a partner.

S: 1 kg \rightarrow 1 kilogram.

T: (Show pan balance, defining illustration in Module Overview.) This is a pan balance. Watch what happens when I put a 1-kilogram weight on one of the pans. (Turn and talk.) What will happen when I put a 1-kilogram bag of beans on the other pan?

T: (Put the beans on the other side of the pan balance.) How do we know it’s balanced now?

S: Both sides are the same. \rightarrow Both pans have the same amount on them. That makes it balanced. \rightarrow Both pans have 1 kilogram on them, so they are equal, which balances the scale.

T: (Provide pan balances, gallon-sized sealable bags, and rice.) Work with a partner.

1. Put a 1-kilogram bag of beans on one of the pans.
2. Put the empty bag on the other side and add rice to it until the pan balance is balanced.
3. Answer Problem 1 in the Problem Set.

NOTES ON MATERIALS:
You may decide to make the 1-kilogram benchmark bag of beans hold rice instead. This way students can use the beans to compose their own 1-kilogram bag rather than rice. Beans may be easier for students to pour and clean up in case of a spill. The purpose of using beans and rice is for students to see that 1 kilogram is not just made by rice.

NOTES ON MULTIPLE MEANS OF REPRESENTATION:
Pre-teach new vocabulary and abbreviations, whenever possible making connections to students’ prior knowledge. Highlight the similarities between kilogram and kg to aid comprehension and correct usage.

NOTES ON MULTIPLE MEANS OF ENGAGEMENT:
Provide a checklist of the steps to support students in monitoring their own progress.
Part 2: Decompose 1 kilogram.

Students work in pairs.

T: Be sure your bag is sealed, then lay it flat on your desk. Move the rice to smooth it out until it fills the bag.

T: Using your dry-erase marker, estimate to draw a ten-frame that covers the whole bag of rice. (Ten-frame shown drawn on the bag at right.)

T: The whole bag contains 1 kilogram of rice. We just partitioned the rice into 10 equal parts. These equal parts can be measured with a smaller unit of weight called grams. (Write grams on the board.) Whisper the word grams to your partner.

S: Grams.

T: Each part of the ten-frame is about 100 grams of rice. To record 100 grams, we can abbreviate using the letter g. (Write 100 g on the board.) Write 100 g in each part of the ten-frame.

T: How many hundreds are in 1 kilogram of rice?

S: 10 hundreds!

T: Let’s skip-count hundreds to find how many grams of rice are in the whole bag. Point to each part of the ten-frame as we skip-count.

S: (Point and skip-count.) 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000.

T: How many grams of rice are in the whole bag?

S: 1,000 grams!

T: One kilogram of rice is the same as 10 hundreds, or 1,000 grams of rice.

T: A digital scale helps us measure the weight of objects. Let’s use it to measure 100 grams of rice. To measure weight on this scale, you read the number on the display screen. There is a g next to the display screen, which means that this scale measures in grams. Put an empty cup on your digital scale. Carefully scoop rice from your bag into the cup until the scale reads 100 g.

T: How many grams are still in your bag?

S: 900 grams.

T: How many grams are in your cup?

S: 100 grams.

T: Turn and talk to a partner, will your bag of rice balance the pan balance with the 1-kilogram bag of beans? Why or why not?

T: Check your prediction by using the pan balance to see if the bag of rice balances with the bag of beans.
Lesson 6

Lesson 6:
Build and decompose a kilogram to reason about the size and weight of 1 kilogram, 100 grams, 10 grams, and 1 gram.

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S: (Use pan balance to see the bags are not balanced anymore.)
T: Carefully set the cup of rice on the same pan as the bag of rice. Is it balanced now?
S: Yes, because both sides are 1 kilogram!
T: Pour the rice from the cup back into the bag. How many grams are in the bag?
S: 1,000 grams.
T: Answer Problem 2 on your Problem Set.

Follow the same process to further decompose:

- Partition 100 grams into 10 grams by drawing a new ten-frame within 1 part of the first ten-frame (shown right). Use the digital scale to scoop 100 grams into a cup again and then scoop 10 grams into another cup. How many grams are left in the first cup? How many grams are in the smaller cup? Students pour the rice back into the bag and answer Problem 3.
- Partition 10 grams into 1 gram by drawing a new ten-frame within 1 part of the second ten-frame (shown at right.) Have a discussion about the difficulty of weighing 1 gram using the previous method. Students answer Problem 4.

Problem Set (5 minutes)

Problems 1–4 in the Problem Set are intended to be completed during the Concept Development. Students can use this time to complete Problem 5.

Student Debrief (10 minutes)

Lesson Objective: Build and decompose a kilogram to reason about the size and weight of 1 kilogram, 100 grams, 10 grams, and 1 gram.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience. Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- How are the units kilogram and gram similar? How are they different?
- Explain to a partner how you used a pan balance to create a bag of rice that weighed 1 kilogram.
- Could we have used the digital scale to create a bag of rice that weighs 1 kilogram? Why or why not?
- How many equal parts were there when you partitioned 1 kilogram into 100 grams? 100 grams into 10 grams? 10 grams into 1 gram? How does this relationship help you answer Problem 5?
- What new math vocabulary did we use today to communicate precisely about weight?
- At the beginning of our lesson, we used a number bond to show an hour in two parts that together made the whole. How did we also show parts that together made a whole kilogram?

**Exit Ticket (3 minutes)**

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students’ understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
1. Illustrate and describe the process of making a 1 kilogram weight.

2. Illustrate and describe the process of partitioning 1 kilogram into 100 grams.

3. Illustrate and describe the process of partitioning 100 grams into 10 grams.
4. Illustrate and describe the process of partitioning 10 grams into 1 gram.

5. Compare the two place value charts below. How does today’s exploration using kilograms and grams relate to your understanding of place value?

<table>
<thead>
<tr>
<th>1 kilogram</th>
<th>100 grams</th>
<th>10 grams</th>
<th>1 gram</th>
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<table>
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<tr>
<th>Thousands</th>
<th>Hundreds</th>
<th>Tens</th>
<th>Ones</th>
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</table>
Ten bags of sugar weigh 1 kilogram. How many grams does each bag of sugar weigh?
Lesson 6 Homework

Name ___________________________________________ Date ______________________

1. Use the chart to help you answer the following questions:

<table>
<thead>
<tr>
<th>1 kilogram</th>
<th>100 grams</th>
<th>10 grams</th>
<th>1 gram</th>
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</table>

a. Isaiah puts a **10 gram** weight on a pan balance. How many **1 gram** weights does he need to balance the scale?

b. Next, Isaiah puts a **100 gram** weight on a pan balance. How many **10 gram** weights does he need to balance the scale?

c. Isaiah then puts a **kilogram** weight on a pan balance. How many **100 gram** weights does he need to balance the scale?

d. What pattern do you notice in Parts (a–c)?
2. Read each digital scale. Write each weight using the word *kilogram* or *gram* for each measurement.

- 3 kg
- 6 kg
- 450 g
- 907 g
- 11 kg
- 1 kg
Lesson 7

Objective: Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures.

Suggested Lesson Structure

- Fluency Practice (10 minutes)
- Application Problem (3 minutes)
- Concept Development (37 minutes)
- Student Debrief (10 minutes)
- Total Time (60 minutes)

Fluency Practice (10 minutes)

- Group Counting 3.OA.1 (4 minutes)
- Decompose 1 Kilogram 3.MD.2 (4 minutes)
- Gram Counting 3.MD.2 (2 minutes)

Group Counting (4 minutes)

Note: Group counting reviews interpreting multiplication as repeated addition. The counting by groups in this activity reviews foundational strategies for multiplication from Module 1 and anticipates Module 3.

Direct students to count forward and backward, occasionally changing the direction of the count using the following suggested sequence:

- Threes to 30
- Fours to 40
- Sixes to 60
- Sevens to 70, emphasizing the transition of 63 to 70
- Eights to 80, emphasizing the transition of 72 to 80
- Nines to 90, emphasizing the transition of 81 to 90

As students improve with skip-counting (e.g., 7, 14, 21, 28, etc.) have them keep track of how many groups they have counted on their fingers. Keep asking them to say the number of groups, e.g., “24 is how many threes?” “63 is how many sevens?”
Decompose 1 Kilogram (4 minutes)

Materials: (S) Personal white boards

Note: Decomposing 1 kilogram using a number bond helps students relate part–whole thinking to measurement concepts. It also sets the foundation for work with fractions.

T: (Project a number bond with 1 kg written as the whole.) There are 1,000 grams in 1 kilogram.
T: (Write 900 grams as one of the parts.) On your white boards, write a number bond filling in the missing part.
S: (Draw number bond with 100 g completing the missing part.)

Continue with the following possible sequence: 500 g, 700 g, 400 g, 600 g, 300 g, 750 g, 650 g, 350 g, 250 g, 850 g, and 150 g. Do as many as possible within the four minutes allocated for this activity.

Gram Counting (2 minutes)

Note: This activity reviews Lesson 6 and lays a foundation for Grade 4 when students compose compound units of kilograms and grams.

T: There are 1,000 grams in 1 kilogram. Count by 100 grams to 1 kilogram.
S: 100 grams, 200 grams, 300 grams, 400 grams, 500 grams, 600 grams, 700 grams, 800 grams, 900 grams, 1 kilogram.

Application Problem (3 minutes)

Justin put a 1-kilogram bag of flour on one side of a pan balance. How many 100-gram bags of flour does he need to put on the other pan to balance the scale?

Note: This problem reviews the decomposition of 1 kilogram and the vocabulary words kilogram and gram from Lesson 6. The student work shows exemplary work. Students may also solve with repeated addition or skip-counting. Invite discussion by having students share a variety of strategies.
Concept Development (37 minutes)

Materials: (T) Digital scale in grams (S) Spring scale

Part 1: Become familiar with scales.

(Draw spring scales shown below on the board.)

T: (Show spring scale, defining illustration in Module Overview.) This is a spring scale. There is a g on this scale. That means it can be used to measure grams. Other spring scales measure in kilograms. I've drawn some on the board. (See examples below.)

T: (Point to the first drawing.) This scale shows the weight of a bowl of apples. Each interval on this scale represents 1 kilogram. How much does the bowl of apples weigh?

S: 3 kilograms.

T: Talk to your partner. Where would the arrow point if it weighed 1 kilogram? 4 kilograms?

T: Look at the next scale, weighing rice. Each interval on this scale represents 1 kilogram. How much does the bag of rice weigh?

S: 1 kilogram.

T: Talk to your partner about how this scale would show 6 kilograms. What about 10 kilograms?

T: On the last scale, 5 intervals represent 500 grams. How much does 1 interval represent?

S: 100 grams!

T: Let’s count grams on this scale to find 1 kilogram. (Move finger and count 100 grams, 200 grams, 300 grams, etc.)

T: Where is 1 kilogram on this scale? 200 grams?

S: (Discuss.)

T: (Pass out spring scales that measure in grams.) This scale is labeled in intervals of 200. Skip-count by two-hundreds to find how many grams the scale can measure.
Lesson 7: Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures.

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S: (Point and skip-count.) 200, 400, 600, 800, 1,000, 1,200, 1,400, 1,600, 1,800, 2,000.

T: This scale can measure 2,000 grams. That means that each tick mark represents 20 grams. Working with a partner, start at 0 and skip-count by twenties to find the 100-gram mark on this scale.

S: (Work with a partner and skip-count to 100.) 20, 40, 60, 80, 100.

Continue having students locate weights on this scale with the following possible sequence: 340 g, 880 g, and 1,360 g.

T: To accurately measure objects that weigh less than 20 grams, we are going to use a digital scale. (Show digital scale.) Remember from yesterday, to measure weight on this scale you read the number on the display screen. (Point to display screen.) There is a $g$ next to the display screen, which means that this scale measures in grams. (Model measuring.)

T: We’ll use both a spring scale and a digital scale in today’s exploration.

Part 2: Exploration Activity

Students begin to use estimation skills as they explore the weight of 1 kilogram. In one hand they hold a 1-kilogram weight, and with the other they pick up objects around the room that they think weigh about the same as 1 kilogram. Students determine whether the objects weigh less than, more than, or about the same as 1 kilogram. Encourage students to use the italicized comparative language. Next they weigh the objects using scales and compare their estimates with precise weights. They repeat this process using 100 gram, 10 gram, and 1 gram weights.

Demonstrate the process of using the kilogram weight. For example, pick up the 1-kilogram weight and a small paperback book. Think out loud so the students can hear you model language and thinking to estimate that the book weighs less than 1 kilogram. Repeat the process with an object that weighs more than and about the same as 1 kilogram.

Problem Set (20 minutes)

Materials: (S) 1 kg, 100 g, 10 g, and 1 g weights (or pre-weighed and labeled bags of rice corresponding to each measurement), spring scale that measures up to 2,000 grams, digital scale in grams

Side 1 of the Problem Set is used for the lesson’s exploration. Students should complete Side 2 independently or with a partner.
Lesson Objective: Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience. Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to de brief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- How did you use the 1 kilogram, 100 gram, 10 gram, and 1 gram weights to help you estimate the weights of objects in the classroom?
- Today you used a spring scale and a digital scale to measure objects. How are these scales used differently than the pan balance from yesterday’s lesson?
- Did anyone find an object that weighs exactly 1 kilogram? What object? Repeat for 100 grams, 10 grams, and 1 gram.
- Look at Problem D. List some of the actual weights you recorded (there should be a huge variation in weights for this problem). Why do you suppose there are a small number of weights very close to 1 gram?
- Discuss Problem E with a partner. How did you determine which estimation was correct for each object?
- Have students discuss Problem F. This problem anticipates the introduction of liters in Lessons 9 and 10, hinting at the weight equivalence of 1 liter of water and 1 kilogram.
- Problem G reminds me of a riddle I know: What weighs more, 1 kilogram of bricks or 1 kilogram of feathers? Think about the relationship between the beans and rice in Problem G to help you answer this riddle.
Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students` understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
Lesson 7 Problem Set

Name ___________________________ Date ________________

Work with a partner. Use the corresponding weights to estimate the weight of objects in the classroom. Then check your estimate by weighing on a scale.

<table>
<thead>
<tr>
<th>A.</th>
<th>Objects that weigh About 1 Kilogram</th>
<th>Actual Weight</th>
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<th>B.</th>
<th>Objects that Weigh About 100 Grams</th>
<th>Actual Weight</th>
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<th>C.</th>
<th>Objects that Weigh About 10 Grams</th>
<th>Actual Weight</th>
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<tr>
<th>D.</th>
<th>Objects that Weigh About 1 Gram</th>
<th>Actual Weight</th>
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Lesson 7 Problem Set

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Lesson 7:
Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures.

Date: 7/4/13

E. Circle the correct unit of weight for each estimation.

1. A box of cereal weighs about 350 (grams / kilograms).
2. A watermelon weighs about 3 (grams / kilograms).
3. A postcard weighs about 6 (grams / kilograms).
5. A bicycle weighs about 15 (grams / kilograms).
6. A lemon weighs about 58 (grams / kilograms).

F. During the exploration, Derrick finds that his bottle of water weighs the same as a 1 kilogram bag of rice. He then exclaims, “Our class laptop weighs the same as 2 bottles of water!” How much does the laptop weigh in kilograms? Explain your reasoning.

G. Nessa tells her brother that 1 kilogram of rice weighs the same as 10 bags containing 100 grams of beans each. Do you agree with her? Explain why or why not.
1. Read and write each weight shown on the scales below.

2. Circle the correct unit of weight for each estimation.
   
   a. An orange weighs about 200 (grams / kilograms).
   
   b. A basketball weighs about 624 (grams / kilograms).
   
   c. A brick weighs about 2 (grams / kilograms).
   
   d. A small packet of sugar weighs about 4 (grams / kilograms).
   
   e. A tiger weighs about 190 (grams / kilograms).
Lesson 7: Develop estimation strategies by reasoning about the weight in kilograms of a series of familiar objects to establish mental benchmark measures.

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Name ___________________________________________  Date _____________________________

1. Match the object with its approximate weight.

- [ ] 100 grams
- [ ] 10 grams
- [ ] 1 gram
- [ ] 1 kilogram

2. Alicia and Jeremy weigh a cell phone on a digital scale. They write down 113 but forget to record the unit. Which unit of measurement is correct? How do you know?
3. Read and write the weights below. Write the word *kilogram* or *gram* with the measurement.
Lesson 8

Objective: Solve one-step word problems involving metric weights within 100 and estimate to reason about solutions.

Suggested Lesson Structure

| Fluency Practice | (8 minutes) |
| Concept Development | (42 minutes) |
| Student Debrief | (10 minutes) |
| **Total Time** | **(60 minutes)** |

Fluency Practice (8 minutes)

- Divide Grams and Kilograms 3.MD.2 (2 minutes)
- Determine the Unit of Measure 3.MD.2 (2 minutes)
- Group Counting 3.OA.1 (4 minutes)

Divide Grams and Kilograms (2 minutes)

Note: This activity reviews the decomposition of 1 kg, 100 g, and 10 g using division from Lesson 6, as well as division skills using units of 10 from Module 1.

T: (Project 10 g ÷ 10 = ___.) Read the division sentence.
S: 10 grams ÷ 10 = 1 gram.

Continue with the following possible sequence: 100 g ÷ 10, 1,000 g ÷ 10.

Determine the Unit of Measure (2 minutes)

Note: This activity reviews the difference in size of and uses for grams and kilograms as units of measurement from Lesson 7.

T: I’ll name an object. You say if it should be measured in grams or kilograms. Apple.
S: Grams.

Continue with the following possible sequence: carrot, dog, pencil, classroom chair, car tire, and paper clip.
Lesson 8

Lesson 8: Solve one-step word problems involving metric weights within 100 and estimate to reason about solutions.

Date: 7/4/13

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Group Counting (4 minutes)

Note: Group counting reviews interpreting multiplication as repeated addition. The group counting in this activity reviews foundational multiplication strategies from Module 1, and anticipates units used in Module 3.

Direct students to count forward and backward, occasionally changing the direction of the count:

- Threes to 30
- Fours to 40
- Sixes to 60
- Sevens to 70
- Eights to 80
- Nines to 90

As students advance in fluency with skip-counting a particular unit, have them track the number of groups counted on their fingers.

Concept Development (42 minutes)

Materials: (T) Scale (S) Spring scales that measure grams, personal white boards, 1-kg bag of rice, pinto beans (baggies of 80 beans per pair), popcorn kernels (baggies of 30 kernels per pair)

Problem 1: Solve one-step word problems using addition.

Pairs of students have spring scales and baggies of pinto beans and popcorn kernels.

T: Let’s use spring scales to weigh our beans and kernels. Should we use grams or kilograms?
S: Grams!
T: Compare the feel of 80 pinto beans and 30 popcorn kernels. Which do you think weighs more?
S: (Pick up bags and estimate.)
T: Work with your partner to weigh the beans and kernels. Record the weights on your board.
S: (Weigh and record. Beans will weigh about 28 grams and kernels will weigh about 36 grams.)
T: Was your estimation correct? Tell your partner. (Students share.)
T: Let’s add to find the total weight of the beans and kernels. Solve the problem on your board.
(Students solve.)
T: I noticed someone used a simplifying strategy to add. They noticed that 28 grams is very close to 30 grams. Thirty is an easier number to add than 28. Watch how they made a ten to add. (Model sequence below.)

\[
\begin{align*}
28 \text{ g} + 36 \text{ g} &= 64 \text{ g} \\
30 \text{ g} + 34 \text{ g} &= 64 \text{ g}
\end{align*}
\]

NOTES ON MULTIPLE MEANS OF ACTION AND EXPRESSION:

Depending on timing and the variety of strategies used to solve, you may want to select a few students to share work.
Lesson 8: Solve one-step word problems involving metric weights within 100 and estimate to reason about solutions.

Date: 7/4/13

T: How might this strategy help us solve other similar problems using mental math?
S: From 28 it was easy to make 30, so I guess when there’s a number close to a ten, like 39 or 58, we can just get 1 or 2 out of the other number to make a ten. → Yeah, it is easy to add tens like 20, 30, 40. → So 49 + 34 becomes 49 + 1 + 33, then 50 + 33 = 88. → Oh! One just moved from 34 to 49!

T: Tell your partner how we could have used our scales to find the total weight.
S: We could have weighed the beans and kernels together!
T: Do that now to check your calculation.

Problem 2: Solve one-step word problems using subtraction.

T: (Project compare lesser unknown problem with result unknown.) Lindsey wants to ride the roller coaster. The minimum weight to ride is 32 kilograms. She weighs 14 kilograms less than the required weight. How many kilograms does Lindsey weigh?
T: Work with your partner to draw and write an equation to model the problem. (Students model.)
T: How will you solve? Why will you do it that way?
S: (Discuss, most agree on subtraction: 32 kg – 14 kg.)
T: Talk with your partner about how you might use tens to make a simplifying strategy for solving.
S: How about 32 – 10 – 4? → Or we could break 14 into 10 + 2 + 2. Then it’s easy to do 32 – 2 – 10 – 2.
T: Solve the problem now. (Select one to two pairs of students to demonstrate their work.)

As time allows, repeat the process.

- Take from with result unknown: Ms. Casallas buys a new cabinet for the classroom. It comes in a box that weighs 42 kilograms. Ms. Casallas unpacks pieces that total 16 kilograms. How much does the box weigh now?

- Take from with change unknown: Mr. Flores weighs 73 kilograms. After exercising every day for 6 weeks he loses weight. Now he weighs 67 kilograms. How much weight did he lose?

Problem 3: Solve one-step word problems using multiplication.

T: Let’s use a digital scale to measure the exact weight of Table 1’s supply box. (Model weighing.)
T: It weighs about 2 kilograms. Talk with your partner. Is it reasonable to suppose that the supply boxes at each table weigh about 2 kilograms?
S: No because ours has more crayons than the blue table’s. → But it’s not very many crayons and they don’t weigh very much. Besides, the teacher said about 2 kilograms. → It’s reasonable because they are the same box, and they all have almost the exact same things in them.
T: How are we using a simplifying strategy by supposing that each of the boxes weighs about 2 kilograms?
MP.4

S: It’s simpler because we don’t have to weigh everything. → It’s simplifying because then we can just multiply the number of boxes times 2 kilograms. Multiplying by two is easier than adding a bunch of different numbers together.

T: Partner A, model and solve this problem. Explain your solution with Partner B. Partner B, check your friend’s work. Then write and solve a different multiplication sentence to show the problem. Explain to or model for Partner A why your multiplication sentence makes sense, too.

S: (Partner A models and writes $6 \times 2$. Partner B checks work, and writes and explains $2 \times 6$.)

As time allows, repeat the process.

- **Equal measures with unknown product**: Jerry buys 3 bags of groceries. Each bag weighs 4 kilograms. How many kilograms do Jerry’s grocery bags weigh in all?
- **Equal measures with unknown factor**: A dictionary weighs 3 kilograms. How many kilograms do 9 dictionaries weigh?

**Problem 4: Solve one-step word problems using division.**

T: (Project.) 8 chairs weigh 24 kilograms. What is the weight of 1 chair? Work with your partner to model or write an equation to represent the problem.

S: (Model and/or write $24 \div 8 = \_\_\_.)$

T: What will be your strategy for solving?

S: We can skip-count by eights, just like we practiced in today’s fluency!

As time allows, repeat the process.

- **Equal measures with group size unknown**: Thirty-six kilograms of apples are equally distributed into 4 crates. What is the weight of each crate?
- **Equal measures with number of groups unknown**: A tricycle weighs 8 kilograms. The delivery truck is almost full, but can hold 40 kilograms more. How many more tricycles can the truck hold?

**Problem Set (10 minutes)**

Students should do their personal best to complete the Problem Set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students solve these problems using the RDW approach used for Application Problems.
**Student Debrief (10 minutes)**

**Lesson Objective:** Solve one-step word problems involving metric weights within 100 and estimate to reason about solutions.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience. Invite students to review their solutions for the Problem Set.

They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to de brief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- How did your tape diagrams change in Problem 1(a) and 1(b)?
- Explain to your partner the relationship between Problem 2(a) and Problem 2(b).
- How did today’s fluency help you with problem solving during the Concept Development?
- Select students to share simplifying strategies or mental math strategies they used to solve problems in the problem set. If no one used a special strategy or mental math, brainstorm about alternative ways for solving Problem 2.

**Exit Ticket (3 minutes)**

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students’ understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
1. Tim goes to the market to buy fruits and vegetables. He weighs some string beans and some grapes.

![String beans and grapes]

List the weights for both the string beans and grapes.

The string beans weigh _______ grams.

The grapes weigh _______ grams.

2. Use tape diagrams to model the following problems. Keiko and her brother Jiro get weighed at the doctor’s office. Keiko weighs 35 kilograms and Jiro weighs 43 kilograms.

   a. What is Keiko and Jiro’s total weight?

   ![Tape diagram]

   Keiko and Jiro weigh _______ kilograms.

   b. How much heavier is Jiro than Keiko?

   ![Tape diagram]

   Jiro is _______ kilograms heavier than Keiko.
3. Jared estimates that his houseplant is as heavy as a 5-kilogram bowling ball. Draw a tape diagram to estimate the weight of 3 houseplants.

4. Jane and her 8 friends go apple picking. They share what they pick equally. The total weight of the apples they pick is shown to the right.
   a. About how many kilograms of apples will Jane take home?
   
   b. Jane estimates that a pumpkin weighs about as much as her share of the apples. About how much do 7 pumpkins weigh altogether?
The weights of a backpack and suitcase are shown below.

- **a.** How much heavier is the suitcase than the backpack?
- **b.** What is total weight of 4 identical backpacks?
- **c.** How many backpacks weigh the same as one suitcase?
1. The weights of 3 fruit baskets are shown below.

   ![Basket A](12kg)  
   ![Basket B](8kg)  
   ![Basket C](16kg)

   a. Basket _____ is the heaviest.
   b. Basket _____ is the lightest.
   c. Basket A is _________ kilograms heavier than Basket B.
   d. What is the total weight of all three baskets?

2. Each journal weighs about 280 grams. What is total weight of 3 journals?

3. Ms. Rios buys 453 grams of strawberries. She has 23 grams left after making smoothies. How many grams of strawberries did she use?
4. Andrea’s dad is 57 kilograms heavier than Andrea. Andrea weighs 34 kilograms.

   a. How much does Andrea’s dad weigh?

   b. How much do Andrea and her dad weigh in total?

5. Jennifer’s grandmother buys carrots at the farm stand. She and her 3 grandchildren equally share the carrots. The total weight of the carrots she buys is shown below.

   a. How many kilograms of carrots will Jennifer get?

   b. Jennifer uses 2 kilograms of carrots to bake muffins. How many kilograms of carrots does she have left?
Lesson 9

Objective: Decompose a liter to reason about the size of 1 liter, 100 milliliters, 10 milliliters, and 1 milliliter.

Suggested Lesson Structure

- Fluency Practice (4 minutes)
- Concept Development (46 minutes)
- Student Debrief (10 minutes)
- Total Time (60 minutes)

Fluency Practice (4 minutes)

- Decompose 1 Kilogram 3.MD.2 (4 minutes)

Decompose 1 Kilogram (4 minutes)

Materials: (S) Personal white boards

Note: Decomposing 1 kilogram using a number bond helps students relate part–whole thinking to measurement concepts.

T: (Project a number bond with 1 kg written as the whole.) There are 1,000 grams in 1 kilogram.
T: (Write 900 g as one of the parts.) On your boards, write a number bond filling in the missing part.
S: (Students draw number bond with 100 g completing the missing part.)

Continue with the following possible sequence: 500 g, 700 g, 400 g, 600 g, 300 g, 750 g, 650 g, 350 g, 250 g, 850 g, and 150 g.

Concept Development (46 minutes)

Materials: (T) Beaker, 2-liter bottle (empty, top cut off, without label), ten-frame, 12 clear plastic cups (labeled A–L), dropper, one each of the following sizes of containers: cup, pint, quart, gallon (labeled 1, 2, 3, and 4, respectively)

Part 1: Compare the capacities of containers with different shapes and sizes.

T: (Measure 1 liter of water using a beaker. Pour it into the 2-liter bottle. Use a marker to draw a line...
at the water level in the bottle and label it 1L. Have containers 1–4 ready.)

T: Which holds more water, a swimming pool or a glass?
S: A swimming pool!
T: Which holds more water, a swimming pool or a bathtub?
S: A swimming pool!
T: Which holds the least amount of water, a swimming pool, a bathtub, or a glass?
S: A glass holds the least amount of water.
T: The amount of liquid a container holds is called its **capacity**. The glass has the smallest capacity because it holds the least amount of water. (Show bottle.) Is this container filled to capacity?
S: No!
T: The amount of water inside measures 1 **liter**. A liter is a unit we use to measure amounts of liquid. To abbreviate the word **liter** use a capital L. (Show the side of the bottle.) Use your finger to write the abbreviation in the air.

T: Let’s compare the capacities of different containers by pouring 1 liter into them to see how it fits. (Show Container 1 and the bottle side by side.) Talk to your partner. Predict whether Container 1 holds more, less, or about the same as 1 liter. Circle your prediction on Part 1, Problem A of your Problem Set.

S: (Discuss and circle predictions.)
T: I’ll pour water from the bottle into Container A to confirm our predictions. (Pour.) Is the capacity of Container 1 more or less than 1 liter?
S: Less!
T: Does that match your prediction? What surprised you? Why?
S: (Discuss.)
T: Next to the word **actual** on Problem A write less.

Repeat the process with Containers 2–4. Container 2 holds less than 1 liter, Container 3 holds about the same as 1 liter, and Container 4 holds more than 1 liter. Then have students complete Problem B.

**Part 2: Decompose 1 liter.**

T: (Arrange empty cups A–J on the ten-frame, shown below. Measure and label the water levels on Cup K at 100 milliliters and Cup L at 10 milliliters.)

T: We just compared capacities using a **liquid volume** of 1 liter. We call an amount of liquid **liquid volume**. Whisper the words **liquid volume**.

S: Liquid volume.
T: Now we’re going to partition 1 liter into smaller units called **milliliters**. Say the word **milliliter**. (Students say the word.)
T: To abbreviate milliliter we write mL. (Model.) Write the abbreviation in the air.
T: We’ll partition our liter into 10 parts. Each square of our ten-frame shows 1 part. (Show Cup K.) This cup is marked at 100 milliliters. We’ll use it to measure the liquid volume that goes into each cup on the ten-frame.

Labeled Cups A–J on a ten-frame.

T: (Fill Cup K to the 100 mL mark. Empty Cup K into Cup A.) How much water is in Cup A?
S: 100 milliliters!
T: (Repeat with Cups B–J.) How many cups are filled with 100 milliliters?
S: 10 cups!
T: Is there any water left in the bottle?
S: No!
T: We partitioned 1 liter of water into 10 parts, each with a liquid volume of about 100 milliliters. Skip-count hundreds to find the total milliliters on the ten-frame. (Point to each cup as students count.)
S: 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000.
T: How many milliliters of water are in 1 liter?
S: 1,000 milliliters!
T: Talk to your partner about how this equation describes our work. (Write: $1,000 \text{ mL} \div 10 = 100 \text{ mL}$.)
S: (Discuss.)
T: Answer Problem C on your Problem Set. Include the equation written on the board.
S: (Students skip-count as 9 cups are emptied back into the bottle. Empty the final cup into Cup K.)
T: Let’s partition again. This time we’ll pour the 100 milliliters in Cup K into 10 equal parts using the ten-frame. How many milliliters will be in each of the 10 cups?
S: 10 milliliters. 10 groups of 10 makes 100.
T: Cup L is marked at 10 milliliters. (Show Cups K and L side by side.) How do the marks on each cup compare?
S: The mark on Cup L is closer to the bottom.
T: Why is Cup L’s mark lower than Cup K’s?
S: Cup L shows 10 milliliters. That is less than 100 milliliters. Cup L shows a smaller liquid volume.
T: (Repeat the process of partitioning outlined above.)
Lesson 9: Decompose a liter to reason about the size of 1 liter, 100 milliliters, 20 milliliters, and 1 milliliter.

Date: 7/4/13

Lesson Objective: Decompose a liter to reason about the size of 1 liter, 100 milliliters, 20 milliliters, and 1 milliliter.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

 Invite students to review their solutions for the problem set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- Revisit predictions from Part 1. Lead a discussion about why students may have thought taller containers had larger capacities. Guide students to articulate understanding about conservation and capacity.
Review the difference between capacity and liquid volume.

In the equations for Part 2, why are the first number and quotient in each followed by the word milliliters? Why not the 10?

How is decomposing 1 liter similar to decomposing 1 kilogram?

How do our decompositions of 1 liter and 1 kilogram remind you of the place value chart?

**Exit Ticket (3 minutes)**

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students’ understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
Part 1

a. Estimate whether each container holds less than, more than, or the same as 1 liter.

<table>
<thead>
<tr>
<th>Container</th>
<th>Comparison</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>holds</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>less than / greater than / the same as</td>
<td>1 liter</td>
</tr>
<tr>
<td>3</td>
<td>less than / greater than / the same as</td>
<td>1 liter</td>
</tr>
<tr>
<td>4</td>
<td>less than / greater than / the same as</td>
<td>1 liter</td>
</tr>
</tbody>
</table>

b. After measuring, what surprised you? Why?

Part 2

c. Illustrate and describe the process of partitioning 1 liter of water into 10 cups.
d. Illustrate and describe the process of partitioning Cup K into 10 smaller units.

e. Illustrate and describe the process of partitioning Cup L into 10 smaller units.

f. What is the same about breaking 1 liter into milliliters and breaking 1 kilogram into grams?

g. One liter of water weighs 1 kilogram. How much does 1 milliliter of water weigh? Explain how you know.
Lesson 9 Exit Ticket

Name ___________________________________________ Date ____________________

1. Morgan fills a 1-liter jar with water from the pond. She uses a 100-mL cup to scoop water out of the pond and pour it into the jar. How many times will Morgan scoop water from the pond to fill the jar?

2. How many groups of 10 mL are in 1 liter? Explain.

There are _________ groups of 10 mL in 1 liter.
Name ____________________________ Date __________________

1. Find containers at home that have a capacity of about 1 liter. Use the labels on containers to help you identify them.
   a. Name of Container

<table>
<thead>
<tr>
<th>Name of Container</th>
<th>Example: Carton of Orange Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

   b. Sketch the containers. How do their size and shape compare?

2. The doctor prescribes Mrs. Larson 5 milliliters of medicine each day for 3 days. How many milliliters of medicine will she take altogether?
3. Mrs. Goldstein pours 3 juice boxes into a bowl to make punch. Each juice box holds 236 milliliters. How much juice does Mrs. Goldstein pour into the bowl?

4. Daniel’s fish tank holds 24 liters of water. He uses a 4-liter bucket to fill the tank. How many buckets of water are needed to fill the tank?

5. Sheila buys 15 liters of paint to paint her house. She pours the paint equally into 3 buckets. How many liters of paint are in each bucket?
Lesson 10

Objective: Estimate and measure liquid volume in liters and milliliters using the vertical number line.

Suggested Lesson Structure

- Fluency Practice (10 minutes)
- Application Problem (5 minutes)
- Concept Development (35 minutes)
- Student Debrief (10 minutes)
- Total Time (60 minutes)

Fluency Practice (10 minutes)

- Milliliter Counting 3.MD.2 (2 minutes)
- Decompose 1 Liter 3.MD.2 (4 minutes)
- Group Counting 3.OA.1 (4 minutes)

Milliliter Counting (2 minutes)

Note: This activity reviews Lesson 9 and lays a foundation for eventually composing compound units of liters and milliliters in Grade 4.

T: There are 1,000 milliliters in 1 liter. Count by 100 milliliters to 1 liter.
S: 100 milliliters, 200 milliliters, 300 milliliters, 400 milliliters, 500 milliliters, 600 milliliters, 700 milliliters, 800 milliliters, 900 milliliters, 1 liter.

Decompose 1 Liter (4 minutes)

Materials: (S) Personal white boards

Note: Decomposing 1 liter using a number bond helps students relate part–whole thinking to measurement concepts.

T: (Project a number bond with 1 liter written as the whole.) There are 1,000 milliliters in 1 liter.
T: (Write 900 mL as one of the parts.) On your boards, write a number bond filling in the missing part.
S: (Draw number bond with 100 mL completing the missing part.)

Continue with possible sequence of 500 mL, 700 mL, 400 mL, 600 mL, 300 mL, 750 mL, 650 mL, 350 mL, 250 mL, 850 mL, and 150 mL.
Lesson 10

Estimate and measure liquid volume in liters and milliliters using the vertical number line.

Date: 7/4/13

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Group Counting (4 minutes)

Note: Group counting reviews interpreting multiplication as repeated addition. It reviews foundational strategies for multiplication from Module 1 and anticipates Module 3.

Direct students to count forward and backward, occasionally changing the direction of the count:

- Threes to 30
- Fours to 40
- Sixes to 60
- Sevens to 70
- Eights to 80
- Nines to 90

As students’ fluency with skip-counting increases, have them track the number of groups counted with their fingers in order to make the connection to multiplication.

Application Problem (5 minutes)

Subha drinks 4 large glasses of water each day. How many large glasses of water does she drink in 7 days?

Note: This problem activates prior knowledge about solving multiplication word problems using units of 4. It is designed to lead into a discussion of liquid volume in the Concept Development.

Concept Development (35 minutes)

Materials: (T) 1-liter beaker (S) Pitcher of water (1 per group), empty 2-liter bottle with top cut off (1 per group), 1 plastic cup pre-measured and labeled at 100 mL, 1 permanent marker.

Notes on Materials:
The bottles used in this exploration should be as close to the shape of a cylinder as possible. This will create a more precise vertical number line with tick marks that are equidistant from one another. Many soda bottles have grooves on the bottom and a thinner waistline, which will skew the tick marks and create uneven intervals on the number line.
Part 1: Create a vertical number line marked at 100 mL intervals.

T: (Make groups of three students.) Each group will measure liquid volume to make a measuring bottle that contains 1 liter of water, similar to the one we used yesterday. Each group member has a job. One person will be the measurer, 1 one will be the pourer, and the other will be the marker. Take 30 seconds to decide on jobs.

S: (Decide.)

T: The marker should draw a straight, vertical line from top to bottom. (Pictured right.) These are the rest of the directions:

- The measurer measures 100 milliliters of water by pouring from the pitcher into the plastic cup.
- The pourer holds the plastic cup in place and helps the measurer know when to stop. Then the pourer pours the water from the cup into the bottle.
- The marker makes horizontal lines to show each new water level on the side of the bottle. Each horizontal line should cross the vertical line. The horizontal lines should be about the same size, and one should be right above the other.

T: There are 1,000 milliliters in 1 liter of water. You are measuring 100 milliliters each time. Think back to yesterday. How many times will you need to measure and mark 100 milliliters of water to make 1 liter?

S: 10 times.

T: Go ahead and get started.

S: (Measure, pour, and mark until there are 10 horizontal lines on the bottle, and 1 liter of water inside.)

T: What do the tick marks and line remind you of?

S: They look like the number line! \(\rightarrow\) It’s going up and down instead of sideways.

T: Another way to say up-and-down is vertical. It’s a vertical number line. Point to the tick mark that shows the most liquid volume.

S: (Point to the top-most horizontal mark.)

T: Use the word milliliters or liters to tell your group the capacity indicated by that mark.

S: 1,000 milliliters. \(\rightarrow\) 1 liter.

T: To the right of the mark, label 1 L.

(Repeat the process for the mark that shows the least liquid volume and label 100 mL.)

T: With your group, use the vertical number line to find the mark that shows about halfway to 1 liter. Discuss the value of the mark in milliliters. Make sure you all agree.

S: (Find the mark; agree that the value is 500 mL)

T: Label the halfway mark.

S: (Label 500 mL)
Lesson 10: Estimate and measure liquid volume in liters and milliliters using the vertical number line.

Part 2: Use the vertical number line to estimate and precisely measure liquid volume.

T: You’ve made a tool that scientists and mathematicians use to measure liquid volume. It’s called a beaker. (Show a beaker.) Work with your group to answer all three parts of Problem 1 in your Problem Set.

S: (Groups pour the liter of water from measuring bottle into pitcher.)

T: A small water bottle has about 200 milliliters of water inside. Let’s see what 200 milliliters looks like. Pour from your pitcher to the measuring bottle to see the capacity of a small water bottle.

S: (Pour and measure 200 mL.)

T: How did your group use the vertical number line to measure?

S: Each tick mark represents 100 milliliters. We knew the water level was at 200 milliliters when it reached the second tick mark.

T: Is the water level in your bottle less than halfway, more than halfway, or about halfway to a liter?

S: Less than halfway.

T: A larger water bottle has about 500 milliliters of water inside. How many milliliters should you add to your measuring bottle so that the liquid volume is the same as that of a larger water bottle?

S: 300 milliliters.

T: How many tick marks higher should the water level rise if you are adding 300 milliliters?

S: Three tick marks higher.

T: Add 300 milliliters of water to your measuring bottle.

S: (Pour and measure 300 milliliters.)

T: Is the water level in your bottle less than halfway, more than halfway, or about halfway to a liter?

S: About halfway.

Repeat the process with the following sequences:

- 700 mL, 900 mL, 1,000 mL
- 250 mL, 450 mL (These will be estimates. This is an opportunity to discuss halfway between two tick marks.)
Lesson 10

Lesson 10: Estimate and measure liquid volume in liters and milliliters using the vertical number line.

Date: 7/4/13

Problem Set (10 minutes)

Students should do their best to complete Problems 2–4 within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students solve these problems using the RDW approach used for Application Problems.

Student Debrief (10 minutes)

Lesson Objective: Estimate and measure liquid volume in liters and milliliters using the vertical number line.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- In Problem 4, describe how the position of the points plotted in Part (a) helped you solve Parts (b) and (c).
- Students may have different answers for Problem 4 (d). (Barrel B is closest to 70, but Barrel A has enough capacity to hold 70 liters, plus a little extra.) Invite students with both answers a chance to explain their thinking.
- Compare the beaker with your measuring bottle.
- How would we have labeled our vertical number lines differently if we had measured 10 mL instead of 100 mL cups to make our measuring bottles?
- If we had measured 10 mL instead of 100 mL cups to make our measuring bottles, would our halfway mark be the same or different? How do you know?
- Would our estimates change if our bottles had marks at every 10 mL instead of every 100 mL?
Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students’ understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
Lesson 10: Estimate and measure liquid volume in liters and milliliters using the vertical number line.

Name ________________________________________ Date _________________________

1. Label the vertical number line on the container to the right. Answer the questions below.
   
a. What did you label at the halfway mark? Why?
   
b. Explain how pouring each cup of water helped you create a vertical number line.
   
c. If you pour out 300 mL of water, how many mL are left in the container?

2. How much liquid is in each container?

   ![Container with liquid levels]

   - [ ] 1L
   - [ ] 2L
   - [ ] 3L
   - [ ] 4L
   - [ ] 5L
   - [ ] 6L
3. Estimate the amount of liquid in each container to the nearest milliliter.

4. The chart below shows the capacity of 4 barrels.

<table>
<thead>
<tr>
<th>Barrel</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>75 liters</td>
</tr>
<tr>
<td>B</td>
<td>68 liters</td>
</tr>
<tr>
<td>C</td>
<td>96 liters</td>
</tr>
<tr>
<td>D</td>
<td>52 liters</td>
</tr>
</tbody>
</table>

a. Label the number line to show the capacity of each barrel. Barrel A has been done for you.

b. Which barrel has the greatest capacity?

c. Which barrel has the smallest capacity?

d. Ben buys a barrel that holds about 70 liters. Which barrel did he most likely buy? Explain why.

e. Use the number line to find how many more liters Barrel C can hold than Barrel B.
1. Use the number line to record the capacity of the containers.

<table>
<thead>
<tr>
<th>Container</th>
<th>Capacity in liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

2. What is the difference between the capacity of Container A and Container C?
1. How much liquid is in each container?

   ![Image of containers with liquid levels]

   __________  __________  __________  __________

2. Jon pours the contents of Container 1 into Container 3. How much liquid is in Container 3 after he pours the liquid?

3. Estimate the amount of liquid in each container to the nearest liter.

   ![Image of containers with liquid levels]

   __________  __________  __________  __________
4. Kristen is comparing the capacity of gas tanks of cars. Use the chart below to answer the questions.

<table>
<thead>
<tr>
<th>Size of car</th>
<th>Capacity in liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>74</td>
</tr>
<tr>
<td>Medium</td>
<td>57</td>
</tr>
<tr>
<td>Small</td>
<td>42</td>
</tr>
</tbody>
</table>

a. Label the number line to show the capacity of each gas tank. The medium car has been done for you.

b. Which car’s gas tank has the greatest capacity?

c. Which car’s gas tank has the least capacity?

d. Kristen’s car has a gas tank capacity of about 60 liters. Which car from the chart has about the same capacity as Kristen’s car?

e. Use the number line to find how many more liters the large car’s tank holds than the small car’s tank.
Lesson 11

Objective: Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units.

Suggested Lesson Structure

- Fluency Practice (11 minutes)
- Concept Development (39 minutes)
- Student Debrief (10 minutes)
- Total Time (60 minutes)

Fluency Practice (11 minutes)

- Rename Tens 3.NBT.3 (3 minutes)
- Halfway on the Number Line 3.NBT.1 (4 minutes)
- Read a Beaker 3.MD.1 (4 minutes)

Rename Tens (3 minutes)

Materials: (T) Hide Zero Cards (S) Personal white boards

Note: This activity anticipates rounding in Lessons 13 and 14. You may want to use Hide Zero cards to quickly review place value with students if necessary.

T: (Write 7 tens = ____.) Say the number.
S: 70.

Continue with the following possible sequence: 8 tens, 9 tens, and 10 tens.

T: (Write 11 tens = ____.) On your boards, fill in the number sentence.
S: (Write 11 tens = 110.)

Continue with the following possible sequence: 12 tens, 16 tens, 19 tens, and 15 tens.

Halfway on the Number Line (4 minutes)

Materials: (S) Personal white boards

Note: This activity anticipates rounding in the next topic. Practicing this skill in isolation lays a foundation for conceptually understanding rounding on a vertical number line.

T: (Project a vertical line with ends labeled 0 and 10.) What’s halfway between 0 tens and 1 ten?
Lesson 11

Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units.

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NOTES ON MULTIPLE MEANS OF REPRESENTATION:
This anticipatory activity is the first use of halfway in the context of a number line. You may need to preview the word. It is bolded as new vocabulary and included in the Debrief of Lesson 12 because it is formally introduced and used repeatedly within the Concept Development.

S: 5.
T: (Write 5 halfway between 0 and 10.)

Repeat process with ends labeled 10 and 20.

T: Draw a vertical number line on your personal boards and make tick marks at each end and one for a halfway point.
S: (Draw number line.)
T: (Write 3 tens and 4 tens.) Label the ends and write the halfway point.
S: (Label 30 as the bottom point, 40 as the top point, and 35 as the halfway point.)

Continue with the following possible sequence: 60 and 70, 80 and 90, 40 and 50, and 50 and 60.

Read a Beaker (4 minutes)

Materials: (T) Beaker images (S) Personal white boards

Note: This activity reviews Lesson 10.

T: (Show image of a beaker with a capacity of 4 liters.) Start at the bottom of the beaker and count by 1 liter. (Move finger from the bottom to each tick mark as students count.)
S: 1 liter, 2 liters, 3 liters, 4 liters.
T: I’ll shade in the beaker to show how much water it holds. Write the capacity on your board.
(Shade in 1 liter.)
S: (Write 1 liter.)
Repeat the process, varying the liquid height.
Repeat the process with a beaker partitioned into 10 equal parts, filling in increments of 100 milliliters.
Repeat the process with a beaker partitioned into 2 equal parts, filling in an increment of 500 milliliters.

Concept Development (39 minutes)

Materials: (T) Scale (S) Spring scales, digital scales, beakers (mL), personal white boards

Problem 1: Solve word problems involving addition and subtraction.

T: (Project.) A pet mouse weighs 34 grams. A pet hamster weighs 126 grams more than the mouse. Model the problem on your board.
S: (Model.)
T: Talk with your partner: Is there a simplifying strategy you might you use to find how much the hamster weighs?
S: 126 grams is almost 130 grams. We can use the 4 from 34 to complete the ten in 126 and make 130.
Lesson 11

Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units.

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Then it’s just 30 + 130. That’s easy!

\[ 345 + 1263 = ? \]
\[ 30 + 4 + 126 = \]
\[ 30 + 130 = 160 \, \text{g} \]

T: How might this strategy help us solve similar problems using mental math?
S: We can look for other problems with 6 in the ones place and see if getting 4 makes a simpler problem.
→ We can look for ways to make a ten.

As time allows, repeat the process.

- **Add to with result unknown:** Judith squeezes 140 milliliters of lemon juice to make 1 liter of lemonade. How many milliliters of lemon juice are in 2 liters of lemonade?
- **Take from with change unknown:** Robert’s crate of tools weighs 12 kilograms. He takes his power tools out. Now the crate weighs 4 kilograms. How many kilograms do the power tools weigh?

**Part 2: Solve word problems involving multiplication.**

T: (Project.) A pitcher of shaved ice needs 5 milliliters of food coloring to turn red. How many milliliters of food coloring are needed to make 9 pitchers of shaved ice red? Explain to your partner how you would represent and solve this problem.

T: Go ahead and solve.
S: (Solve problem.)

T: (Pick two students that used different strategies to share.)
S: (Share.)

As time allows, repeat the process.

- **Equal groups with unknown product:** Alyssa drinks 3 liters of water every day. How many liters will she drink in 8 days?
- **Equal groups with unknown product:** There are 4 grams of almonds in each bag of mixed nuts. How many grams of almonds are in 7 bags?

**NOTES ON MULTIPLE MEANS OF ENGAGEMENT:**
This lesson includes an abundance of word problems given in all four operations. It is unlikely that you will have time for them all. As you make decisions about pacing, select problems involving operations with which your class most needs practice, and intentionally vary the problem types.

**NOTES ON MULTIPLE MEANS OF ACTION AND EXPRESSION:**
Students may come up with a variety of strategies. Strategically choose students to share their work, highlighting for the rest of the class particularly efficient methods. Use what students share to build a bank of strategies, and encourage students to try a friend’s strategy to solve subsequent problems.

**NOTES ON MULTIPLE MEANS OF ENGAGEMENT:**
This lesson includes an abundance of word problems given in all four operations. It is unlikely that you will have time for them all. As you make decisions about pacing, select problems involving operations with which your class most needs practice, and intentionally vary the problem types.
Lesson 11

NYS COMMON CORE MATHEMATICS CURRICULUM

Part 3: Solve word problems involving division.

T: Let’s work in groups to solve the following problem. (Group students.)

T: (Project.) At the pet shop there are 36 liters of water in a tank. Each fish bowl holds 4 liters. How many fish bowls can the shopkeeper fill using the water in the tank?

T: Go ahead and solve.

S: (Solve problem.)

T: (Pick groups that used different strategies to share.)

S: (Share.)

As time allows, repeat the process:

- **Equal groups with number of groups unknown:** Every day the school garden gets watered with 7 liters of water. How many days until the garden has been watered with 49 liters?
- **Equal groups with group-size unknown:** A bin at the grocery store holds 9 kilograms of walnuts. The total value of 9 kilograms of walnuts is $36. How much does 1 kilogram of walnuts cost?

As time allows, have students work in pairs to solve one-step word problems using all four operations.

- **Take apart with addend unknown:** Together an orange and a mango weigh 637 grams. The orange weighs 385 grams. What is the weight of the mango?
- **Compare with difference unknown:** A rabbit weighs 892 grams. A guinea pig weighs 736 grams. How much more does the rabbit weigh than the guinea pig?
- **Equal groups with group size unknown:** Twenty-four kilograms of pineapple are needed to make 4 identical fruit platters. How many kilograms of pineapple are required to make 1 fruit platter?
- **Equal groups with unknown product:** The capacity of a pitcher is 3 liters. What is the capacity of 9 pitchers?
- **Add to with result unknown:** Jack uses a beaker to measure 250 milliliters of water. Angie measures double that amount. How many milliliters of water does Angie measure?

Problem Set (10 minutes)

Students should do their personal best to complete the problem set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students solve these problems using the RDW approach used for Application Problems.
Student Debrief (10 minutes)

**Lesson Objective:** Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- What models did you use to solve word problems?
- Explain the process you used for solving Problem 1. Did you use a special strategy? What was it?
- What pattern did you notice between Problems 4, 5, and 6? How did that pattern help you solve the problems?
- Explain why Problem 6 was more challenging to solve than Problems 4 and 5.
- Look at Problem 6. Why is it important to measure the capacity of an object before dividing into equal amounts?

Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students’ understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.
Lesson 11 Problem Set

NYS COMMON CORE MATHEMATICS CURRICULUM

Lesson 11: Solve mixed word problems involving all four operations with grams, kilograms, liters, and milliliters given in the same units.

Date: 7/4/13

Name ________________________________ Date ____________________________

1. The total weight in grams of a can of tomatoes and a jar of baby food is shown at right.
   a. The jar of baby food weighs 113 grams. How much does the can of tomatoes weigh?

   b. How much more does the can of tomatoes weigh than the jar of baby food?

2. The weight of a pen in grams is shown at right.
   a. What is the total weight of 10 pens?

   b. An empty box weighs 82 grams. What is the total weight of a box of 10 pens?

3. The total weight of an apple, lemon, and banana in grams is shown at right.
   a. If the apple and lemon together weigh 317 grams, what is the weight of the banana?

   b. If we know the lemon weighs 68 grams less than the banana, how much does the lemon weigh?

   c. What is the weight of the apple?
4. A frozen turkey weighs about 5 kilograms. The chef orders 45 kilograms of turkey. Use a tape diagram to find about how many frozen turkeys he orders.

5. A recipe requires 300 milliliters of milk. Sara decides to triple the recipe for dinner. How many milliliters of milk does she need to cook dinner?

6. Marian pours a full container of water equally into buckets. Each bucket has a capacity of 4 liters. After filling 3 buckets, she still has 2 liters left in her container. What is the capacity of her container?
1. The capacities of three cups are shown below.

- Cup A: 160 mL
- Cup B: 280 mL
- Cup C: 237 mL

a. Find the total capacity of the three cups.

b. Bill drinks exactly half of Cup B. How much is left in Cup B?

c. Anna drinks 3 cups of tea in Cup A. How much tea does she drink in total?
1. Karina goes on a hike. She brings a notebook, a pencil, and a camera. The weight of each item is shown in the chart. What is the total weight of all three items?

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notebook</td>
<td>312 g</td>
</tr>
<tr>
<td>Pencil</td>
<td>10 g</td>
</tr>
<tr>
<td>Camera</td>
<td>365 g</td>
</tr>
</tbody>
</table>

The total weight is _________ grams.

2. Together a horse and its rider weigh 729 kilograms. The horse weighs 625 kilograms. How much does the rider weigh?

The rider weighs _________ kilograms.
3. Theresa’s soccer team fills up 6 water coolers before the game. Each water cooler holds 9 liters of water. How many liters of water did they fill?

4. Dwight purchased 48 kilograms of fertilizer for his garden. He needs 6 kilograms of fertilizer for each bed of vegetables. How many beds of vegetables can he fertilize?

5. Nancy bakes 7 cakes for the school bake sale. Each cake requires 5 milliliters of oil. How many milliliters of oil does she use?