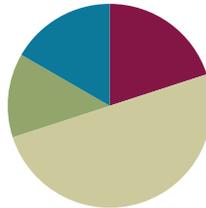


Lesson 4

Objective: Use exponents to denote powers of 10 with application to metric conversions.

Suggested Lesson Structure

■ Fluency Practice	(12 minutes)
■ Application Problems	(8 minutes)
■ Concept Development	(30 minutes)
■ Student Debrief	(10 minutes)
Total Time	(60 minutes)



Fluency Practice (12 minutes)

- Multiply and Divide Decimals by 10, 100, and 1000 **5.NBT.2** (5 minutes)
- Write the Unit as a Decimal **5.NBT.1** (2 minutes)
- Write in Exponential Form **5.NBT.2** (3 minutes)
- Convert Units **4.MD.1** (2 minutes)

Multiply and Divide Decimals by 10, 100, and 1000 (5 minutes)

Materials: (S) Personal white boards

Note: This fluency drill will review concepts taught in earlier lessons and help students work towards mastery in multiplying and dividing decimals by 10, 100, and 1000.

T: (Project place value chart from millions to thousandths. Write 3 disks in the tens column, 2 disks in the ones column, and 4 disks in the tenths column.) Say the value as a decimal.

S: 32.4 (thirty-two and four tenths).

T: Write the number on your personal boards and multiply it by ten.

Students write 32.4 on their place value charts, cross out each digit, and shift the number one place value to the left to show 324.

T: Show 32.4 divided by 10.

Students write 32.4 on their place value charts, cross out each digit, and shift the number one place value to the right to show 3.24.

Repeat the process and sequence for 32.4×100 ; $32.4 \div 100$; $837 \div 1000$; and 0.418×1000 .

Write the Unit as a Decimal (2 minutes)

Materials: (S) Personal white boards

Note: Reviewing these skills will help students work towards mastery of decimal place value, which will in turn help them apply their place value skills to more difficult concepts.

- T: 9 tenths.
 S: 0.9
 T: 10 tenths.
 S: 1.0

Repeat the process for 20 tenths, 30 tenths, 70 tenths, 9 hundredths, 10 hundredths, 11 hundredths, 17 hundredths, 57 hundredths, 42 hundredths, 9 thousandths, 10 thousandths, 20 thousandths, 60 thousandths, 64 thousandths, and 83 thousandths.

Write in Exponential Form (3 minutes)

Materials: (S) Personal white boards

Note: Reviewing this skill in isolation will lay a foundation for students to apply the skill in multiplication during the lesson.

- T: (Write $100 = 10^2$.) Write 100 in exponential form.
 S: (Students write $100 = 10^2$.)

Repeat the process for 1000, 10,000, and 1,000,000.

Convert Units (2 minutes)

Materials: (S) Personal white boards

Note: Reviewing conversions in isolation will lay a foundation for students to apply this knowledge through multiplication and division during the lesson.

Use this quick fluency to activate prior knowledge of these familiar equivalents.

- T: (Write $1 \text{ km} = \underline{\hspace{1cm}} \text{ m}$.) Fill in the missing number.
 S: (Students write $1 \text{ km} = 1000 \text{ m}$.)

Repeat process and procedure for $1 \text{ kg} = \underline{\hspace{1cm}} \text{ g}$, $1 \text{ liter} = \underline{\hspace{1cm}} \text{ mL}$, $1 \text{ m} = \underline{\hspace{1cm}} \text{ cm}$.



**NOTES ON
 MULTIPLE MEANS
 OF ACTION AND
 ENGAGEMENT:**

Consider posting a class-size place value chart as an aid to students in visualizing the unit work of this fluency activity.

It may also be fruitful to have students verbalize their reasoning about the equivalence of 10 tenths to 1.0, 20 tenths to 2.0, etc.

Application Problem (8 minutes)

Mr. Brown wants to withdraw \$1,000 from his bank and in ten dollar bills. How many ten dollar bills should he receive?

Note: Use this problem with a familiar context of money to help students begin to use various units to rename the same quantity—the focus of today’s lesson.

Concept Development (30 minutes)

Materials: (S) Meter strip, markers

Each problem set below includes conversions both from larger to smaller units and smaller to larger units. Allow students the time to reason about how the change in the size of the unit will affect the *quantity* of units needed to express an equivalent measure rather than giving rules about whether to multiply or divide.

Problem 1

Draw a line that is 2 meters long and convert it to centimeters and **millimeters**.

- T: Draw a line 2 meters long.
 S: (Students draw.)
 T: With your partner, determine how many centimeters equal 2 meters.
 S: 200 centimeters.
 T: How is it that the same line can measure both 2 meters and 200 centimeters?
 T: Discuss with a partner how we convert from 2 meters to 200 centimeters?
 S: (After talking with a partner.) Multiply by 100.
 T: Why didn’t the length change? Discuss that with your partner.

Repeat the same sequence with millimeters.

- T: Can we represent the conversion from meters to centimeters or meters to millimeters with exponents? Discuss this with your partner.

Let them see that to convert to centimeters from meters, we multiplied by 10^2 , while to convert from meters to millimeters we multiplied by 10^3 . Repeat the same sequence in reverse so that students see that to convert from centimeters to meters we divide by 10^2 and to convert from millimeters to meters we divide by 10^3 . If there seems to be a large lack of clarity do another conversion with 1 meter or 3 meters.



**NOTES ON
MULTIPLE MEANS
OF ACTION AND
ENGAGEMENT:**

As discussions ensue about conversions from meters to kilometers, centimeters and millimeters, take the opportunity to extend thinking by asking students to make a conversion to the unit that is $1/10$ as large as a meter (decimeter) and the unit 10 times as large (decameter). Students can make predictions about the names of these units or do research about these and other metric units that are less commonly used. Students might also make connections to real world mathematics by investigating industry applications for the less familiar units.

MP.3

Problem 2

Convert 1.37 meters to centimeters and millimeters.

T: Draw a line 1 meter 37 centimeters long.

S: (Students draw.)

T: What fraction of a whole meter is 37 centimeters?

S: 37 hundredths.

T: Write 1 and 37 hundredths as a decimal fraction.

T: With your partner, determine how many centimeters is equal to 1.37 meters both by looking at your meter strip and line and writing an equation using an exponent.

T: What is the equivalent measure in centimeters?

S: 137 centimeters.

T: Show the conversion using an equation with an exponent.

S: $1.37 \text{ meters} = 1.37 \times 10^2 = 137 \text{ centimeters}$.

T: What is the conversion factor?

S: 10^2 or 100.

Repeat the sequence with conversion to millimeters, both with multiplication by 10^3 and division by 10^3 , 2.6, and 12.08.

Problem 3

A cat weighs 4.5 kilograms. Convert its weight to grams.

A dog weighs 6700 grams. Convert its weight to kilograms.

T: Work with a partner to find both the cat's weight in grams and the dog's weight in kilograms. Explain your reasoning with an equation using an exponent for each problem.

S: (Students solve.) $4.5 \text{ kg} \times 10^3 = 4500 \text{ g}$ and $6700 \text{ g} \div 10^3 = 6.7 \text{ kg}$.

T: What is the conversion factor for both problems?

S: 10^3 or 1000.

Repeat this sequence with 2.75 kg to g, and then 6007 g to 6.007 kg and the analogous conversion dividing grams by 10^3 to find the equivalent amount of kilograms.

T: Let's relate our meter to millimeter measurements to our kilogram to gram conversions.

The most important concept is the equivalence of the two measurements—that is, the weight measurement, like that of the linear measurement, did not change. The change in the type of unit precipitates a change in the number of units. However, the weight has remained the same. Clarify this understanding before moving on to finding the conversion equation by asking, "How can 6007 and 6.007 be equal to each other?" (While the numeric values differ, the unit size is also different. 6007 is grams. 6.007 is kilograms. Kilograms are 1000 times as large as grams. Therefore it takes a lot fewer kilograms to make the same amount as something measured in grams.) Then, lead students to articulate that conversions from largest to smallest units we multiplied by 10^3 , to convert from smallest to largest, we need to divide by 10^3 .

MP.4
MP.5

Problem 4

$0.6 \text{ L} \times 10^3 = 600 \text{ mL}$; 0.6×10^2 ; $764 \text{ mL} \div 10^3 = 0.764 \text{ liters}$

- a. The baker uses 0.6 liter of vegetable oil to bake brownies. How many milliliters of vegetable oil did he use? He is asked to make 100 batches for a customer. How many liters of oil will he need?
- b. After gym class, Mei Ling drank 764 milliliters of water. How many liters of water did she drink?

After solving the baker problem, have students share about what they notice with the measurement conversions thus far.

- S: To convert from kilometers to meters, kilograms to grams, liters to milliliters, we multiplied by a conversion factor of 1000 to get the answer.
 → We multiply with a conversion factor of 100 to convert from meters to centimeters. → When we multiply by 1000, our number shifts 3 spaces to the left on the place value chart. When we divide by 1000, the number shifts 3 spaces to the right. → The smaller the unit is, the bigger the quantity we need to make the same measurement.

Repeat this sequence, converting 1,045 mL to liters and 0.008 L to milliliters. Ask students to make comparisons between and among conversions and conversion factors.

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.

In this Problem Set, we suggest all students begin with Problem 1 and leave Problem 6 to the end if they have time.

Student Debrief (10 minutes)

Lesson Objective: Use exponents to denote powers of 10 and with application to metric conversions.

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 worksheet and process the

The image shows a student worksheet titled "NYS COMMON CORE MATHEMATICS CURRICULUM" with the student's name "Kevin" and date "3/6". The worksheet contains the following problems and solutions:

- Convert the larger metric units into smaller metric units.
 - a) Convert 3 meters to centimeters: $3 \text{ m} \times 100 = 300 \text{ cm}$
 - b) Convert 0.9 meters to centimeters: $0.9 \text{ m} \times 100 = 90 \text{ cm}$
 - c) Convert 8.3 liters to milliliters: $8.3 \text{ L} \times 1,000 = 8,300 \text{ mL}$
 - d) Convert 0.537 liters to milliliters: $0.537 \text{ L} \times 1,000 = 537 \text{ mL}$
 - e) Convert 90.5 kilometers to meters: $90.5 \text{ km} \times 1,000 = 90,500 \text{ m}$
 - f) Convert 0.234 km to meters: $0.234 \text{ km} \times 1,000 = 234 \text{ m}$
 - g) Convert 6.4 kilograms to grams: $6.4 \text{ kg} \times 1,000 = 6,400 \text{ g}$
 - h) Convert 0.6 kilograms to grams: $0.6 \text{ kg} \times 1,000 = 600 \text{ g}$
- Explain why converting from meters to centimeters uses a different conversion factor (x 100) than converting from liters to milliliters, kilometers to meters, and kilograms to grams (x 1000). Express the conversions (g) and (h) above using exponents.

A meter is 100 times greater than a centimeter, so you multiply by 100.
 A liter is 1000 times greater than a milliliter, and a kilogram and kilometer are 1000 times greater than a gram and meter.

 - g) $6.4 \text{ kg} \times 10^3 = 6,400 \text{ g}$
 - h) $0.6 \text{ kg} \times 10^3 = 600 \text{ g}$
- Read each aloud as you write the equivalent measures.
 - a) $3.5 \text{ km} = 3 \text{ km } 500 \text{ m}$
 - b) $1.23 \text{ L} = 1 \text{ L } 230 \text{ mL}$
 - c) $2.002 \text{ kg} = 2 \text{ kg } 2 \text{ g}$
 - d) $3 \text{ mL} = 0.003 \text{ L}$
 - e) $3012 \text{ g} = 3.012 \text{ kg}$
 - f) $0.021 \text{ m} = 2.10 \text{ cm}$

The worksheet footer includes "COMMON CORE", "Lesson 4: Date: 3/6/13", "Lesson Name: EXACTLY GS-M7-7A-14 Worksheet 3.00x", "engage ny", and "©2013 Common Core, Inc. All rights reserved. commoncore.org".

lesson. You may choose to use any combination of the questions below to lead the discussion.

- Reflect on the kinds of thinking you did on Task 1 and Task 2. How are they alike? How are they different?
- How did you convert centimeters to meters? What is the conversion factor?
- How did you convert meters to centimeters? What is the conversion factor?
- In Task 3, how did you convert from meters to **millimeters**? What conversion factor did you use?
- What can you conclude about the operation you use when converting from a small unit to a large unit? When converting from a large unit to a small unit?
- Students might journal about the meanings of *centi-*, *milli-* and even other units like *deci-* and *deca-*.
- Which is easier for you to think about: converting from larger to smaller units or smaller to larger units? Why? What is the difference in the thinking required to do each?

NYS COMMON CORE MATHEMATICS CURRICULUM

3. The length of the bar for a high jump competition must always be 4.75 m. Express this measurement in millimeters. Explain your thinking using an equation that includes an exponent.

$$4.75 \text{ m} = 4750 \text{ mm}$$

$$4.75 \times 10^3 = 4750$$

4. A honey bee's length measures 1 cm. Express this measurement in meters.

a. Explain your thinking using a place value chart.

$1 \text{ cm} = 0.01 \text{ m}$

b. Explain your thinking using an equation that includes an exponent.

$$1 \div 10^2 = 0.01 \quad 1 \text{ cm} = 0.01 \text{ m}$$

5. James drinks 800 ml of water each day during his workout. Henry drinks 600 ml daily during his workout. If James works out 3 days each week, and Henry works out 5 days each week, how many liters do the boys drink in all each week while working out?

James $800 \text{ mL} \times 3 = 2400 \text{ mL} = 2.4 \text{ L}$

Henry $600 \text{ mL} \times 5 = 3000 \text{ mL} = 3.0 \text{ L}$

5.4 L

The boys drink 5.4 L altogether each week.

COMMON CORE Lesson 4: Use exponents to denote powers of 10 with application to metric conversions. Date: 5/1/13 engage^{ny} 1.A.8

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.

NYS COMMON CORE MATHEMATICS CURRICULUM

6. Katrina needs to tie ribbons around 10 flower arrangements for a party. Each arrangement requires 1.2 m of ribbon. She also needs 3.25 m of ribbon to tie to the balloons for the party. If Katrina buys 15 m of ribbon, will she have enough? If so, how much ribbon (in meters) will she have left? If not, how many more meters of ribbon will she need to buy?

K's ribbon arrangements $\{1.2 \mid 1.2 \mid 1.2\} 12 \text{ m}$ $1.2 \times 10 = 12 \text{ m}$

balloons 3.25 m $325 \div 100 = 3.25 \text{ m}$

$$\begin{array}{r} 12.00 \\ + 3.25 \\ \hline 15.25 \text{ m} \end{array}$$

Katrina won't have enough ribbon. She needs to buy 0.25 m more.

COMMON CORE Lesson 4: Use exponents to denote powers of 10 with application to metric conversions. Date: 5/7/13 engage^{ny} 1.A.9

Name _____

Date _____

1. Convert using an equation with an exponent.

a. 3 meters to centimeters _____ = _____ cm

b. 900 centimeters to meters _____ = _____ m

c. 8.1 liters to milliliters _____ = _____ mL

d. 537 milliliters to liters _____ = _____ L

e. 90.5 kilometers to meters _____ = _____ m

f. Convert 23 meters to kilometers. _____ = _____ km

g. 0.4 kilograms to grams _____ = _____ g

h. 80 grams to kilograms _____ = _____ kg

i. Circle the conversion factor in each equation above. Explain why converting from meters to centimeters uses a different conversion factor than converting from liters to milliliters, kilometers to meters, and kilograms to grams.

2. Read each aloud as you write the equivalent measures.

a. 3.5 km = _____ km _____ m

b. 1.23 L = _____ L _____ mL

c. 2.002 kg = _____ kg _____ g

d. 3 mL = _____ L

e. 3012 g = _____ kg

f. _____ m = 2.10 cm

3. The length of the bar for a high jump competition must always be 4.75 m. Express this measurement in millimeters. Explain your thinking using an equation that includes an exponent.
4. A honey bee's length measures 1 cm. Express this measurement in meters.
- a. Explain your thinking using a place value chart.
- b. Explain your thinking using an equation that includes an exponent.
5. James drinks 800 mL of water each day during his workout. Henry drinks 600 mL daily during his workout. If James works out 3 days each week, and Henry works out 5 days each week, how many liters do the boys drink in all each week while working out?

6. Katrina needs to tie ribbons around 10 flower arrangements for a party. Each arrangement requires 1.2 m of ribbon. She also needs 325 cm of ribbon to tie to the balloons for the party. If Katrina buys 15 m of ribbon, will she have enough? If so, how much ribbon (in meters) will she have left? If not, how many more meters of ribbon will she need to buy?

Name _____

Date _____

1. Convert:

a. 2 meters to centimeters $2 \text{ m} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ cm}$

b. 40 milliliters to liters $40 \text{ mL} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ L}$

2. Read each aloud as you write the equivalent measures.

a. $4.37 \text{ l} = \underline{\hspace{2cm}} \text{ L} \underline{\hspace{2cm}} \text{ mL}$

b. $81.62 \text{ kg} = \underline{\hspace{2cm}} \text{ kg} \underline{\hspace{2cm}} \text{ g}$

Name _____

Date _____

1. Convert:

a. 5 meters to centimeters $5 \text{ m} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ cm}$

b. 60 centimeters to meters $60 \text{ cm} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ m}$

c. 2300 milliliters to liters. $2300 \text{ mL} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ L}$

d. 0.462 liters to milliliters $0.462 \text{ L} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ mL}$

e. 80.4 kilometers to meters $\underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ m}$

f. 0.725 kilometers to meters $\underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ m}$

g. 456 grams to kilograms $\underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ kg}$

h. 0.3 kilograms to grams $\underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ g}$

2. Read each aloud as you write the equivalent measures.

a. $2.7 \text{ km} = \underline{\hspace{2cm}} \text{ km} \underline{\hspace{2cm}} \text{ m}$

b. $3.46 \text{ L} = \underline{\hspace{2cm}} \text{ L} \underline{\hspace{2cm}} \text{ mL}$

c. $5.005 \text{ kg} = \underline{\hspace{2cm}} \text{ kg} \underline{\hspace{2cm}} \text{ g}$

d. $8 \text{ mL} = \underline{\hspace{2cm}} \text{ L}$

e. $4079 \text{ g} = \underline{\hspace{2cm}} \text{ kg}$

3. A dining room table measures 1.78 m long. Express this measurement in millimeters.
- Explain your thinking using a place value chart.
 - Explain your thinking using an equation that includes an exponent.
4. Eric and YiTing commute to school every day. Eric walks 0.81 km and YiTing walks 0.65 km. How far did each of them walk in meters? Explain your answer using an equation that includes an exponent.
5. There were 9 children at a birthday party. Each child drank one 200 mL juice box. How many liters of juice did they drink altogether? Explain your answer using an equation that includes an exponent.