Getting Ready to Teach Unit 3

Learning Path in the Common Core Standards

In this unit, students explore customary and metric measurement, time concepts, and graphing. Students extend their measurement skills for length, capacity, weight, and mass. They measure lengths to a quarter inch and add, subtract, multiply, and divide measurements to solve problems. Students learn to tell time to the hour, half hour, quarter hour, five minutes, and one minute, as well as find elapsed time. Students represent time on a clock as well as a number line and use these models to solve problems. Additionally, this unit presents opportunities to explore categorical data displayed on tables, pictographs, bar graphs, and line plots. In Grade 3, students' work with data and time is closely related to fraction concepts, computations with the four operations, and the number line.

Help Students Avoid Common Errors

Math Expressions gives students opportunities to analyze and correct errors, explaining why the reasoning was flawed.

In this unit, we use Puzzled Penguin to show typical errors that students make. Students enjoy teaching Puzzled Penguin the correct way, why this way is correct, and why Puzzled Penguin made the error. Common errors are presented in Puzzled Penguin features in the following lessons:

- **Lesson 2:** Incorrectly determining the unit that should be used to measure liquid volume
- **Lesson 4:** Choosing the wrong operation when solving a problem involving mass
- **Lesson 10:** Incorrectly determining the end time when given the starting time and the elapsed time

In addition to Puzzled Penguin, there are other suggestions listed in the Teacher Edition to help you watch for situations that may lead to common errors. As a part of the Unit Test Teacher Edition pages, you will find a common error and prescription listed for each test item.

***Math Expressions* VOCABULARY**

As you teach the unit, emphasize understanding of these terms.

- liquid volume
- vertical bar graph
- horizontal bar graph

See the Teacher Glossary.

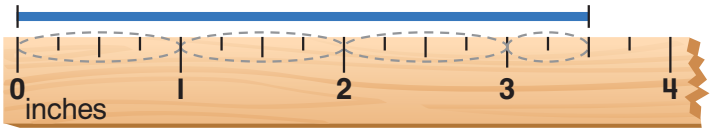
Metric and Customary Measurement

Lessons 1 2 3 4 5

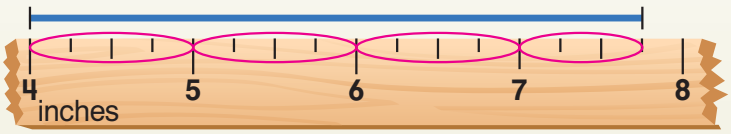
Metric and Customary Systems of Measure In this unit, students measure length, liquid volume, and mass or weight of a variety of objects. They use both the metric and customary systems of measure. As students explore different attributes, such as liquid volume, they use first the customary and then the metric units to measure. This allows students to develop a deeper understanding of each attribute as well as the relationship between the two systems.

Linear Measure Students estimate, measure, and draw lengths using the customary measurement unit—inches. They measure length to a nearest foot, inch, half inch, or quarter inch. Students also explore the properties of a ruler. Lesson 1 presents the ruler as having units that repeat (unit iteration). They learn that a ruler is partitioned, or has large units that are divided into smaller units of the same size. They also conceptualize that more smaller units than larger units are needed to measure any distance (compensatory principle). These generalizable concepts of measurement lay the foundation students need to understand more complicated measurement concepts.

As students use the ruler to measure the length of line segments, they begin with the left end of the segment aligned with the zero-inch mark on the ruler.



Students circle as many inches as possible and then the fraction of an inch that remains. This technique solidifies the understanding that the line segment is a certain number of inches plus some fractional part of an inch long. Circling the units allows students to focus on the number of circles and partial circles rather than the actual numbers on the ruler. Thus, they are able to find accurate measurements even when the left end of the ruler is not aligned with the zero-inch mark.

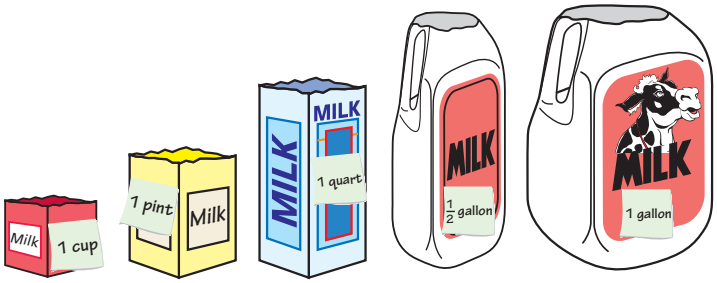


from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Fractional Lengths Grade 3 students also measure lengths using rulers marked with halves and fourths of an inch. They use their developing knowledge of fractions and number lines to extend their work from the previous grade by working with measurement data involving fractional measurement values.

With this technique of measuring, students are more likely to realize that the line segment is $3\frac{3}{4}$ inches even though the right end is aligned with the $7\frac{3}{4}$ mark on the ruler.

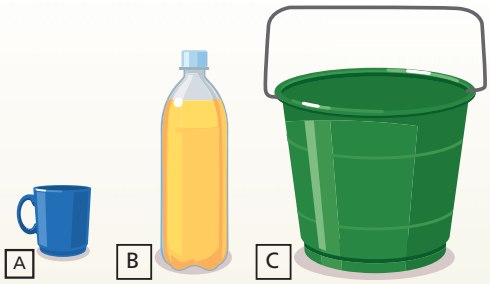
Liquid Volume Lessons 2 and 3 present the customary and metric units of liquid volume. Students consider milk cartons labeled with their liquid volumes—or how much they can hold: 1 cup, 1 pint, 1 quart, $\frac{1}{2}$ gallon, 1 gallon—to learn about customary units of liquid volume.



2 cups = 1 pint 4 cups = 1 quart 8 cups = $\frac{1}{2}$ gallon 16 cups = 1 gallon	2 pints = 1 quart 4 pints = $\frac{1}{2}$ gallon 8 pints = 1 gallon	2 quarts = $\frac{1}{2}$ gallon 4 quarts = 1 gallon	2 half gallons = 1 gallon

Students examine and predict how the sizes of containers relate to each other and use rice or water to fill and compare liquid volumes of the containers. Students state each comparison in an equation in two ways.

Lesson 3 presents the metric units of measure: liter and milliliter—using benchmarks such as a water bottle and eyedropper. Students estimate and compare metric liquid volume using containers with which they are familiar, such as buckets, water bottles, and mugs.



Weight and Mass In Lesson 4, students find benchmarks for ounces, pounds, grams, and kilograms. They estimate the weight or mass of an object. Students also choose an appropriate unit to use when measuring the weight or mass of an object.

from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Measurement Data As the name suggests, measurement data comes from taking measurements. For example, if every child in a class measures the length of his or her hand to the nearest centimeter, then a set of measurement data is obtained.

Time

Lessons 6 7 8 9 10

Reading Time to the Hour, Half Hour, Quarter Hour, and Minute

In the previous grade, students were introduced to telling time to the hour and to five minutes on analog clocks. In Unit 3, students begin by reviewing the features and functions of clocks and telling time to the hour. Then they read time to 15 minutes, 5 minutes, and 1 minute, learning that a single time can be said in several different ways. For example, in the problem below, students may identify the time as two fifty-six, four minutes before three, or fifty-six minutes after two.

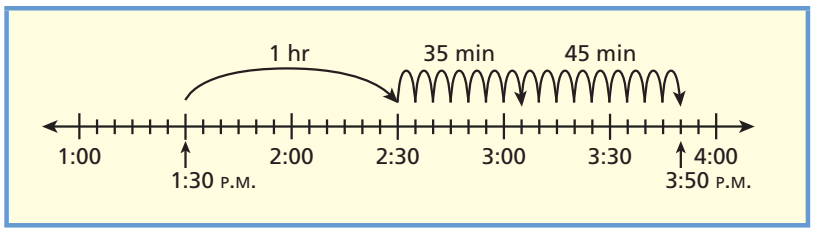
Students use 5s count-bys to help them tell time on an analog clock. Using 5s count-bys allows students to solidify and apply their understanding of multiplication to the concept of time.

Elapsed Time In the previous grade, students found elapsed time in hours and half hours from a start time and an end time. In this unit, students find elapsed time in hours and minutes and use these skills to solve real world problems. The principle that clocks are comprised of iterated units, like all measuring tools, is reinforced as students count the sectors through which the clock hands have traveled to find elapsed time. Elapsed time is represented both on clocks and on number lines.

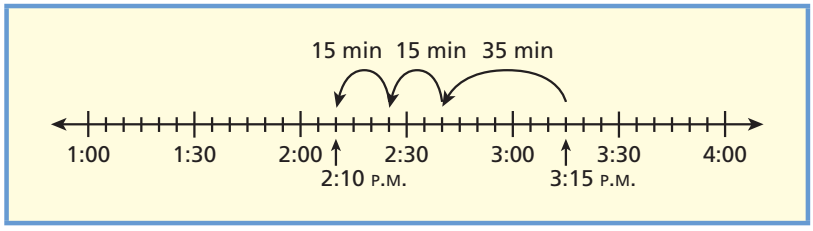
The number line and clock models below help students determine the elapsed time between 1:30 and 4:47.

On both models, students count as many hours as possible, and then count minutes. Students are encouraged to use as many 15, 10, or 5 count-bys as possible before counting single minutes. The variety of representations encourages students to develop flexibility in their understanding of time concepts.

Add and Subtract Time Lesson 9 extends the concept of elapsed time by asking students to add and subtract time. The number line model with which they are familiar is presented as a way to represent these concepts. For example, students would use a number line like the one below to solve a problem in which first 1 hour 35 minutes and then 45 minutes is added to 1:30.



In this example, students use the number line to model a problem in which an end time of 3:15 is given and students have to determine the beginning time.



Notice that in the addition example, students used 5s count-bys to count up from 2:30 to 3:50. In the subtraction example, students count by 15 minutes to count back from 2:40 to 2:10.

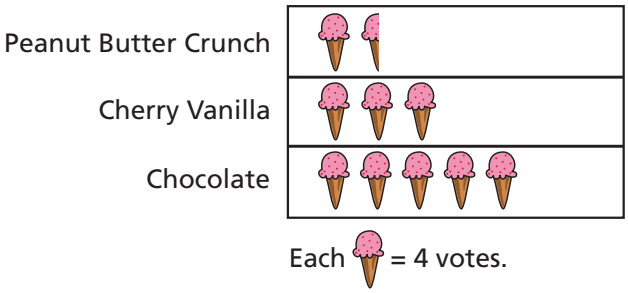
Graphing

Lessons 1 11 12 13

Pictographs In Lesson 11, students analyze categorical data displayed on pictographs. Categorical data comes from sorting objects into categories, for example, sorting votes for favorite ice cream into peanut butter crunch, cherry vanilla, and chocolate. As students interpret the key and symbols on the graph and display data on their own pictographs, they apply their understanding of multiplication and division concepts.

For example, in this graph, students use the number of whole ice cream cones to determine how many times they should count by 4 to find the number of votes for each type of ice cream flavor. Additionally, they determine that a half of an ice cream cone represents half of 4, or 2 votes.

Favorite Ice Cream Flavors



In the example below, students use foundational divisibility concepts to determine that each symbol should represent 2 CDs and introductory division reasoning to determine how many symbols they should use for each type of music.

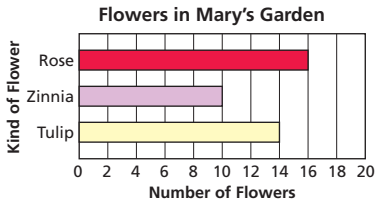
Kanye's CDs	
Type	**Number of CDs**
Jazz	12
Rap	16
Classical	4

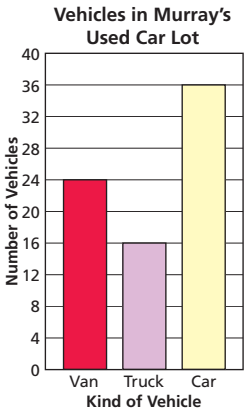
Kanye's CDs	
Jazz	○ ○ ○ ○ ○ ○
Rap	○ ○ ○ ○ ○ ○ ○ ○
Classical	○ ○
Each ○ = 2 CDs.	

from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Categorical Data In Grade 3, the most important development in data representation for categorical data is that students now draw picture graphs in which each picture represents more than one object, and they draw bar graphs in which the height of a given bar in tick marks must be multiplied by the scale factor in order to yield the number of objects in the given category. These developments connect with the emphasis on multiplication in this grade.

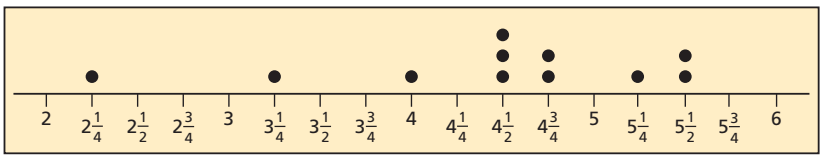
Bar Graphs Lesson 11 presents both horizontal and vertical bar graphs.





Working with bar graph scales builds on students' earlier work with understanding the scale in rulers and how it is built from small lengths. This helps students see the lengths involved in bar graphs, and the bars in bar graphs help students think of the bar graph scale, rulers, and number lines as a length model (for example, the 6 does not mean that point, it means 6 of the length units used in the scale). Work with both horizontal and vertical bar graph scales helps to prepare students for work with such scales on the coordinate plane. Presenting students with bar graphs on which there are multidigit numbers encourages students to make connections between graphing and place value. They apply place value understandings, such as counting by 50s is like counting by 5s and that there are eight tens between 0 and 80 or eight hundreds between 0 and 800. Students' work with categorical data, such as the data they see displayed on the graphs in this part of the unit, will support their later work with bivariate categorical data in later grades.

Line Plots In this unit, students apply their understandings of fractions, number lines, and representing data to analyze and create line plots. In Lesson 1, students connect their comprehension of a ruler to line plots. Just as a ruler is divided into equal sections, so the line on a line plot is divided into equal sections. Students also expand their knowledge of fractions as they place fractional data on the line plot.



Length of Leaves (in Inches)

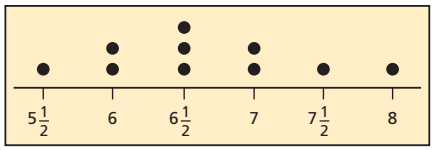
from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Line Plots Other ways to generate measurement data might include measuring liquid volumes with graduated cylinders or measuring room temperatures with a thermometer. In each case, the Standards call for students to represent measurement data with a line plot. This is a type of display that positions the data along the appropriate scale, drawn as a number line diagram. These plots have two names in common use, "dot plot" (because each observation is represented as a dot) and "line plot" (because each observation is represented above a number line diagram).

Students use data that are recorded in tally charts and frequency tables to make line plots.

Tally Chart	
Length in Inches	Tally
$5\frac{1}{2}$	I
6	II
$6\frac{1}{2}$	III
7	II
$7\frac{1}{2}$	I
8	I

Frequency Table	
Length in Inches	Number of Students
$5\frac{1}{2}$	1
6	2
$6\frac{1}{2}$	3
7	2
$7\frac{1}{2}$	1
8	1



Number of Students

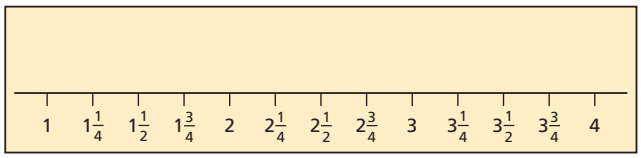
The array and area situations that students encountered in Units 1 and 2 in multiplication and division help them develop proficiency with reading the tables presented in this unit.

Creating Data Displays In this unit, students begin to learn how to choose the appropriate representation to display data. They practice creating a variety of displays on their own in which they are required to correctly label axes and specify units of measure. When they choose the scale of the graphs, they need to attend to precision to choose the scale that is appropriate for the range of numbers. A variety of supports are provided to aid students as they construct their graphs, including blank templates and hands on manipulatives.

from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Creating Graphs Students do not have to generate the data every time they work on making bar graphs and picture graphs. That would be too time-consuming. After some experiences in generating the data, most work in producing bar graphs and picture graphs can be done by providing students with data sets.

Favorite Team Sport	
Sport	Number of Students



Length of Line Segments (in Inches)

In a Differentiated Instruction activity, students are allowed to use cubes and index cards to create a horizontal bar graph.

Problem Solving

Lessons 2 3 5 10 14

Problem Solving Plan In *Math Expressions* a research-based problem solving approach that focuses on problem types is used.

- Interpret the problem
- Represent the situation
- Solve the problem
- Check that the answer makes sense

In this unit, problem solving is infused within each lesson. Students solve problems using measurement, time, and graphing.

Measurement Problems In the measurement lessons, students apply their understanding of measurements and operations as they solve problems in which they have to add, subtract, multiply, or divide measurements. For example, students add units of liquid volume to determine how many gallons of water two aquariums hold, divide units of mass to find out how many grams of sunflower seeds each of 5 friends will get if there are 40 grams of seeds in all, and multiply units of weight to find out how much ham there is if each of 10 slices of ham weighs 2 ounces.

Time Problems In the time lessons, students apply their understanding of time concepts to solve problems involving elapsed time. Students are encouraged to use clocks or number lines to help them represent the problems. A variety of problems are presented in which students need to find the start time, the end time, or the time that has elapsed.

Graphing Problems In the graphing lessons, students interpret and create data displays to solve problems involving a variety of contexts. Bar graphs and pictographs enable students to more easily solve comparison problems, such as determining which category has more or fewer than another and which category has the most or the least. Students solve problems involving fractions by interpreting line plots with fractional data points.

from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Arithmetic and Data In Grades 3–5, work with data is closely related to the number line, fraction concepts, fraction arithmetic, and solving problems that involve the four operations.

from THE PROGRESSIONS FOR THE COMMON CORE STATE STANDARDS ON MEASUREMENT AND DATA

Context "Data are not just numbers, they are numbers with a context. In mathematics, context obscures structure. In data analysis, context provides meaning." In keeping with this perspective, students should work with data in the context of science, social science, health, and other subjects, always interpreting data plots in terms of the data they represent.

Focus on Mathematical Practices

Lesson 15

The standards for Mathematical Practice are included in every lesson of this unit. However, there is an additional lesson that focuses on all eight Mathematical Practices. In this lesson, students use what they know about measurement and graphing to solve problems involving sports.