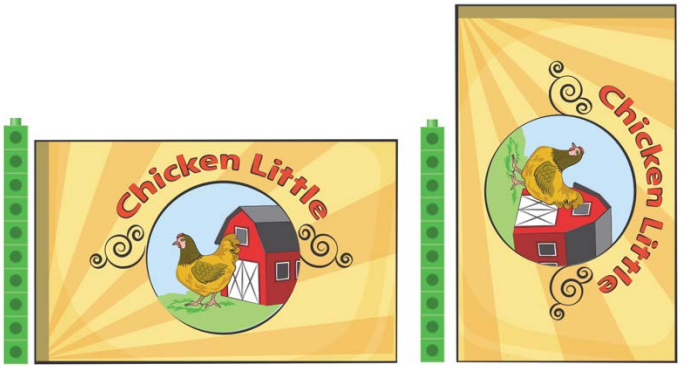
Math Content by Strand

Measurement

Kindergarten

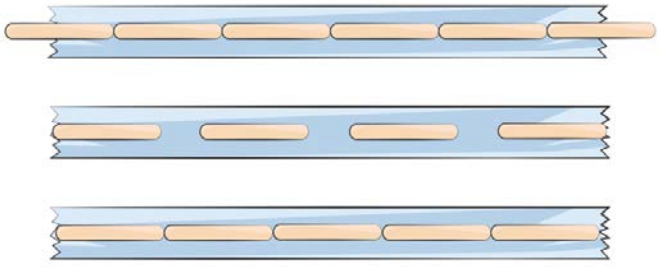
The measurement work begins with students' real-world experiences. They discuss what they know about measuring and think about what could be measured on a given object. For example, given a box that holds pencils or markers, one could measure how tall, wide, or long it is; the distance around it; how much it weighs; or how many pencils or markers fit in it. The measurement work in Kindergarten focuses on length and weight and offers a natural context for applying and practicing counting skills.

Young students' ideas about measuring grow out of a great deal of experience with informal measuring. Comparing is a natural activity. Even very young children spontaneously try to see who or what is bigger, taller, heavier, or smaller. Therefore, students' work with length (and weight) begins with direct comparison. As students directly compare the lengths of objects to determine which is longer, they discuss and make sense of important aspects of accurate measurement, such as choosing which dimension to measure and how to line up objects to compare them.



[Students begin to think about the different dimensions of objects.]

Through such activities and discussions, students learn and become comfortable with the language used to describe length—long, short, wide, tall, high (and their comparative forms—longer, wider, as long as, etc.). These qualitative comparisons inspire students' natural curiosity: "How long is it?" As they investigate questions—such as, "How many cubes long is my shoe?" or "How many craft sticks is the path from the window to the door?"—students apply their counting skills to measurement contexts and begin to think about important ideas in measurement, such as what happens if the units are (or are not) laid straight or if there are (or are not) gaps or overlaps between them. These ideas are explored in subsequent grades.



[Students begin to think about measuring accurately.]

Like the work with linear measurement, students' initial exploration of weight focuses on the direct comparison of objects. Because weight is not a visible attribute in the same way that length is, it can be a more challenging idea, but weight measurement is part of most students' real-world experiences. Students begin by comparing weights directly, first with their hands and then with a pan balance. They use comparative language such as heavy, heavier, light, and lighter to describe the weights of objects. They also quantify weight as they use the pan balance to determine the number of pennies or cubes that weigh the same as an object. This work provides another opportunity to apply and practice counting skills as students answer the question "How much does it weigh?"

A student demonstrates the pan balance when comparing two objects.

MAIN MATH IDEAS

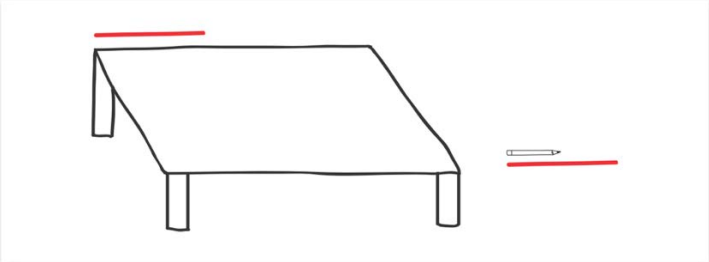
- Understanding length
- Understanding weight
- Counting and representing quantities

Benchmark

- Describe length and decide which of two objects is longer. (Unit 2)

Grade 1

Students develop an understanding of length as a stable and measurable dimension through experiences comparing objects. They determine which of two objects is longer (or shorter) and how much longer (or shorter); order sets of objects from shortest to longest; and indirectly compare objects using a third object.

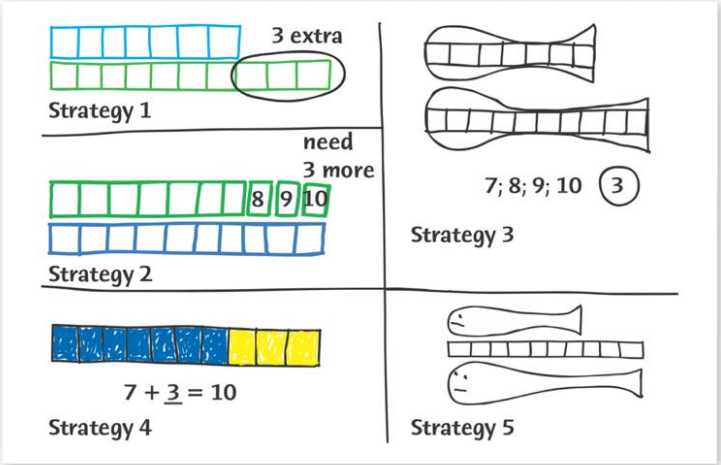


[If the desk is longer than the string, and the string is longer than the pencil, then the desk is longer than the pencil.]

Students practice foundational skills for accurate linear measurement such as knowing when to start and stop measuring, understanding how units must be lined up so as not to create gaps or overlaps, and measuring in a straight line from point to point. Regardless of what object is measured, students learn that when one measures an object twice—or when two different people measure it—the answer should be the same if the unit was the same. Students use string, cubes, paper clips, and inch tiles as units. Though focused on measuring lengths that are a whole number of units, the idea of halves or partial units naturally arises as students measure various objects.

Students practice measuring the length of classroom objects using different units.

This work provides the context for introducing comparison problems about length. Students compare the lengths of fish, which they measure with inch tiles, to determine which is longer (or shorter) than another and how much longer (or shorter). They visualize and model the problems with inch tiles or sketches, and they solve them using a variety of methods.



[The teacher records students' strategies for determining how much longer a 10-inch fish is than a 7-inch fish.]

Understanding time and making sense of the clock as a measurement tool is another form of measurement that students encounter across all Grade 1 units. Students first think about time as they look at the daily schedule. As they consider the day's activities, they hear and use vocabulary that relates to time and sequence (e.g., first, next, last, before, after, during, early, later, at the beginning or end of) and times of day (e.g., morning, afternoon). They associate times on the hour with familiar classroom activities, becoming familiar with digital and analog clock formats. With this foundation, they learn to name and notate times on the hour and half hour, in analog and digital form, and they learn that there are various ways to refer to half hour times (e.g., two-thirty, 30 minutes past 2 o'clock, and half past two).

MAIN MATH IDEAS

- Understanding length
- Using linear units
- Understanding time

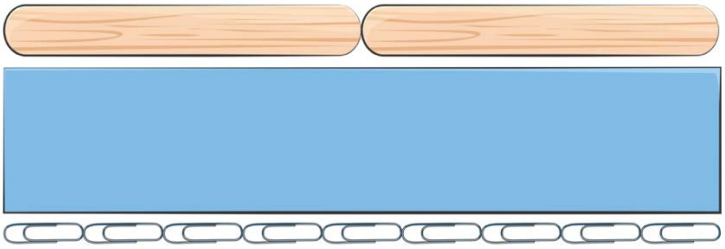
BENCHMARKS

- Compare the lengths of two objects indirectly by using a third length. (Unit 4)
- Demonstrate accurate measuring techniques when measuring an object or distance with multiple units. These techniques include starting at the beginning, ending at the end, leaving no gaps or overlaps, measuring in a straight line, and keeping track of the number of units. (Unit 4)
- Tell time to the hour. (Unit 4)
- Tell time to the half hour. (Unit 8)

Grade 2

Students study measurement in a variety of contexts. They work with time and money, develop their understanding of length and how it is measured, and solve problems in which they relate addition and subtraction to length.

Students use linear units to measure objects and compare measurements. They learn about iterating a unit and about the relationship between the size of a unit and the results of measuring: the smaller the unit, the greater the number of units for the same length.



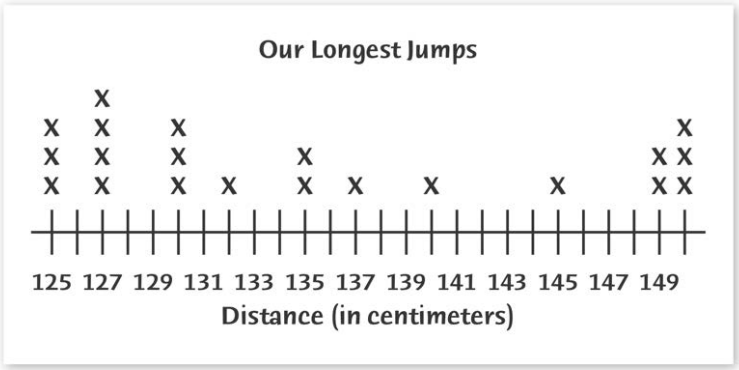
[Students iterate a unit to measure length and consider the relationship between the sizes of units and the results of measuring.]

Students first use non-standard units, such as shoe-lengths, craft sticks, cubes, and paper clips, to measure lengths. By discussing their methods for measuring, students learn that agreeing on a common unit is critical for communicating measurement information to others and comparing results. This leads to work with standard measures.

The experience of iterating a single unit (or multiple units) over a length helps students see the advantage of measurement tools that iterate some number of units in one stable tool. Using individual "inch-bricks," students construct and use their own inch rulers, which fosters not only an understanding of the conventional units, but also the process of measuring with a tool and the principles that underlie the design and use of the tool.

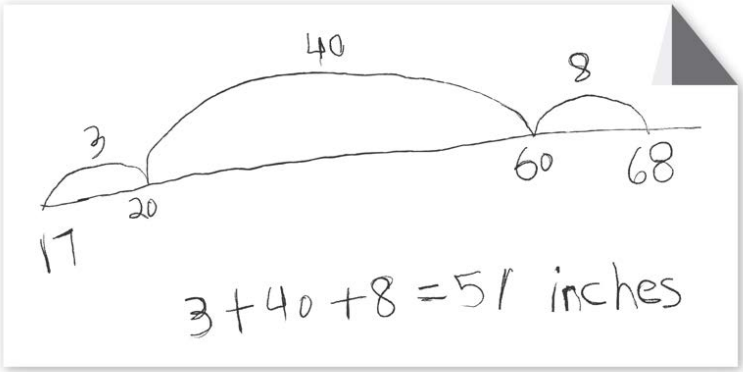
Students make their own 12-inch measuring tool by gluing inch-bricks onto the template.

Students use rulers, yardsticks, and metersticks to measure lengths in U.S. standard units and metric units. They collect data about how far they can jump in inches and centimeters and represent the data on a line plot.



[Students' measurement data is represented on a line plot.]

Measuring and comparing lengths provides a particularly good context for modeling and solving comparison problems (e.g., comparing the length of the longest and shortest jumps and determining the difference).



[A student compares two lengths (17 in. and 68 in.) and finds that the difference is 51 inches.]

Understanding that time can be measured is an important concept that is worked on across all Grade 2 units. After reviewing how to tell time to the hour and half hour, students look at fractional parts of a whole (60 min), partitioning clocks into 2 and then 4 equal parts as an introduction to telling time to the quarter hour. Students come to see those sections as made up of 5-minute intervals, and practice counting around the clock by 5s as a way into telling time to the nearest 5 minutes. Throughout, practice with telling time involves naming times displayed on both digital and analog clocks. Students notate times in digital form. They set analog clocks to times that are read aloud or presented in digital format. They think about what time it will be in one hour, in one half hour, or in 15 minutes. They also think about when daily activities happen, and learn the convention of labeling such times with a.m. or p.m.

MAIN MATH IDEAS

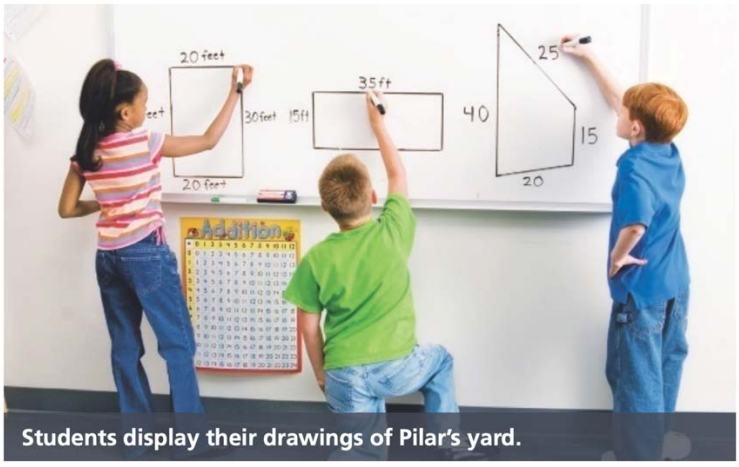
- Using linear units
- Measuring with standard units
- Understanding, representing, and solving problems involving addition and subtraction
- Understanding time

BENCHMARKS

- Recognize that, when measuring the same length, larger units yield smaller counts (and vice versa). (Unit 6)
- Estimate and measure lengths in inches, feet, centimeters, and meters. (Unit 6)
- Solve comparison and other story problems about lengths. (Unit 6)
- Name, notate, and tell time to the nearest 5 minutes using analog and digital formats and associate a.m. and p.m. with time of day. (Unit 8)

Grade 3

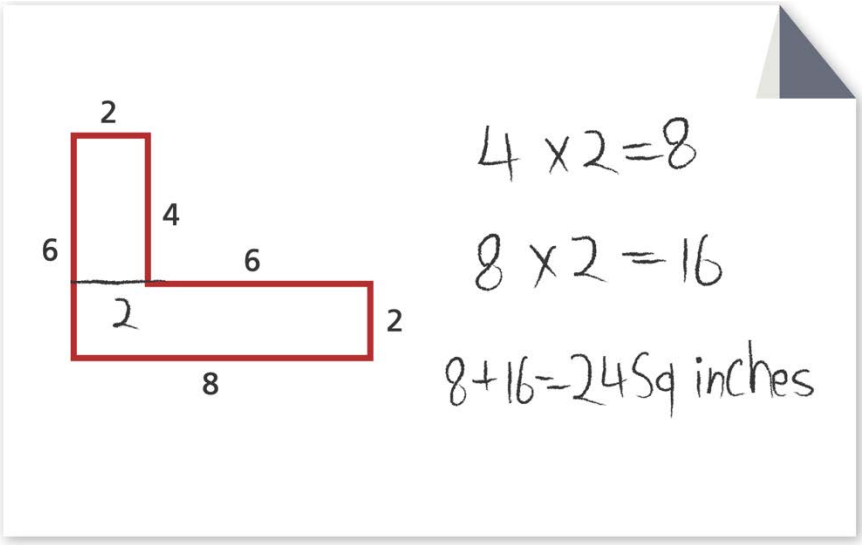
The focus of students' measurement work in Grade 3 is understanding and finding perimeter and area. Perimeter is the distance around the outside edges of a two-dimensional (2-D) shape. Students measure length and calculate perimeter with both U.S. standard units and metric units. They also consider how different shapes can have the same perimeter.



Students display their drawings of Pilar's yard.

Area is the amount of 2-D space a given shape covers and is usually measured in square units. Students first calculate area of rectangles in terms of arrays, skip counting by rows or columns. Then, building on the work they have done with arrays and multiplication, students see that the area of a rectangle can be found by multiplying the length and width.

Students also recognize area as additive: a shape can be decomposed, and its area found by adding the areas of the parts. Students consider how different shapes can have the same area.



Other measurement work in Grade 3 includes generating linear measurement data to the nearest fourth inch and representing those data on a line plot. Students also work with time, liquid volume, and mass. Their work focuses on using measurement tools accurately (rulers, clocks, graduated cylinders, pan balances), establishing measurement benchmarks, and solving word problems that involve measurement.

MAIN MATH IDEAS

- Generating measurement data
- Understanding and finding perimeter
- Understanding and finding area
- Solving problems involving measurement of liquid volume and mass

BENCHMARKS

- Generate measurement data by measuring lengths to the half inch. (Unit 2)
- Tell time to the nearest minute. (Unit 3)
- Measure and find the perimeter of 2-D figures using U.S. standard and metric units. (Unit 4)
- Find the area of 2-D figures using U.S. standard and metric units. (Unit 4)
- Measure to the nearest fourth inch and represent measurement data to the nearest fourth inch on a line plot. (Unit 6)
- Estimate and measure liquid volume and mass using standard units. (Unit 7)
- Find the area of a rectangular array by breaking it apart (using the distributive property). (Unit 8)
- Solve multiplication and division problems involving masses and volumes.

Grade 4

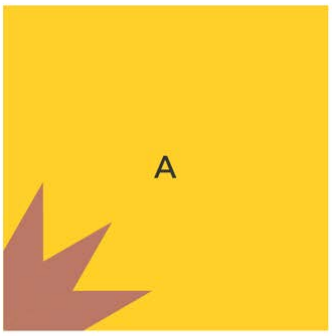
Students continue to build on measurement work from earlier grades, which includes linear measurement, area, angle measurement, and measurement conversions. Students deepen their understanding of perimeter as the distance around a 2-D shape by finding the perimeter of the 2-D faces of objects around their classroom. Students also determine generalizable methods for finding the perimeter of rectangles.

side 1 length + side 2 length + side 3 length + side 4 length

2 × long side length + 2 × short side length

(short side + long side) × 2

Students deepen their understanding of area as the amount of space a shape covers by finding the area of different polygons by using symmetry and non-standard units. Based on their work with arrays in their study of multiplication, students explain and apply a generalizable method for finding the area of a rectangle (multiplying the length by the width). Students learn that angles are measured in terms of an amount of turn or rotation that is part of a circular arc and are measured in degrees. Students also find that angle measure is additive. For instance, if three of the same angles fit together to form a right angle, then each of the smaller angles must be 13 of 90°, or 30° (30°+30°+30°=90°). Using this additive property, students combine and decompose angles whose measures they know, in order to make new angles or to find the measure of other angles. Students also learn to measure angles using a protractor. They choose which scale on the protractor to use by recognizing whether the angle is acute or obtuse.



"STUDENTS MIGHT SAY"

"All of these small angles are the same size so they each have to be 30 to add up to 90 degrees."

Students generate measurement data by measuring lengths to the nearest 14 inch and display their data on a line plot. They use these data to solve addition and subtraction measurement problems involving fractions. See the Data and Rational Numbers sections for more information. Students learn measurement equivalents within a single measurement system and convert measurements (from a larger unit to a smaller unit) using these equivalents. They solve word problems involving time, money, length, weight, mass, liquid volume, and capacity, including multi-step problems involving more than one operation.

MAIN MATH IDEAS

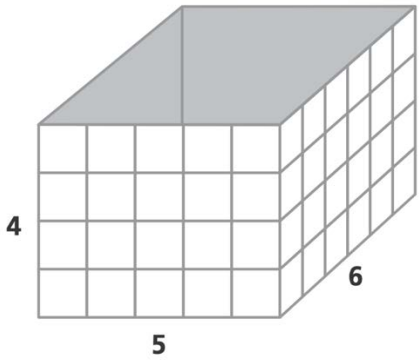
- Generating measurement data
- Solving measurement problems
- Describing and measuring angles
- Understanding and determining area
- Solving measurement problems

BENCHMARKS

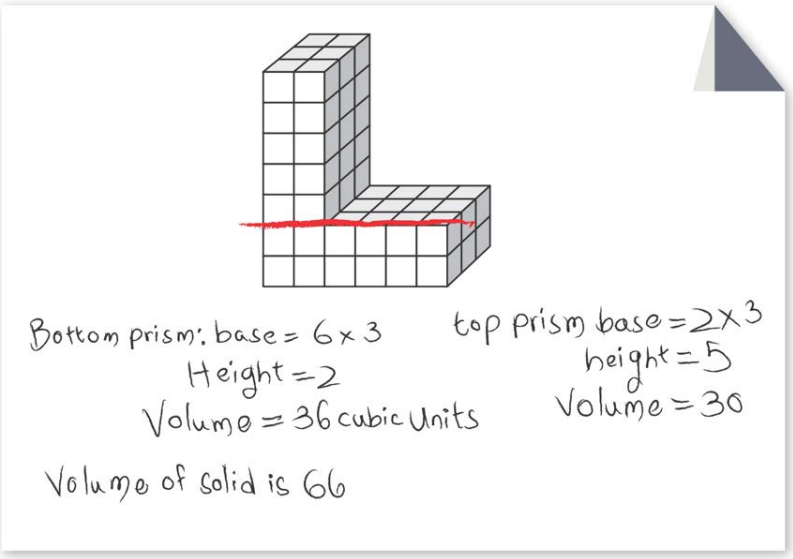
- Convert linear measurements from a larger unit to a smaller unit. (Unit 4)
- Determine the perimeter and area of rectangles, including using generalizable methods. (Unit 4)
- Add or subtract angles to determine the size of angles. (Unit 4)
- Use a protractor to measure angles and sketch angles of specific sizes. (Unit 4)
- Use addition and subtraction to solve word problems involving measurement. (Unit 5)
- Solve measurement and conversion problems. (Unit 7)

Grade 5

A major focus of measurement in Grade 5 involves the structure and volume of three-dimensional (3-D) shapes: specifically, rectangular prisms and solids composed of rectangular prisms. Students create and determine the volume of boxes made from two-dimensional (2-D) patterns and create box patterns to hold a given number of cubes. By doing this work, students learn that the volume of a solid is the space that the solid occupies and can be measured in cubic units. They learn how the volume of a rectangular prism can be found by multiplying length by width by height or multiplying the area of the base of the prism (length x width) by the height.

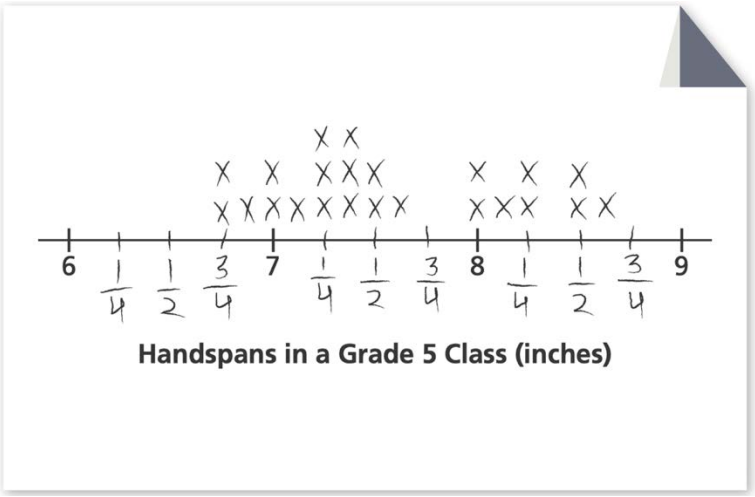


Students also learn that volume is additive. In activities with solids composed of rectangular prisms, students must be able to visualize the prisms that make up the solid, find the volume of each prism, and add these volumes to find the volume of the whole solid.



In the context of their work with multiplication and division, students apply what they have learned about multiplying and dividing rational numbers to convert measurements within a given measurement system, including solving multi-step word problems. Building on measurement ideas from earlier grades, students recognize that converting a larger unit of measure to a smaller unit of measure (e.g., meters to centimeters, yards to feet) results in more of the smaller units; and converting from a smaller unit of measure to a larger unit of measure (e.g., grams to kilograms, quarts to gallons) results in fewer of the larger units.

Students measure lengths to the nearest 14 inch and display their data on a line plot. They solve problems about these lengths.



Handspans in a Grade 5 Class (inches)

MAIN MATH IDEAS

- Translating between two-dimensional and three-dimensional shapes
- Structuring rectangular prisms and determining their volume
- Converting measurements

BENCHMARKS

- Find the volume of rectangular prisms, including the use of volume formulas. (Unit 2)
- Find the volume of a solid composed of two rectangular prisms. (Unit 2)
- Use standard units to measure volume. (Unit 2)
- Represent data including fractions on a line plot and solve addition and subtraction problems about the data. (Unit 3)
- Solve measurement conversion problems including multi-step word problems.