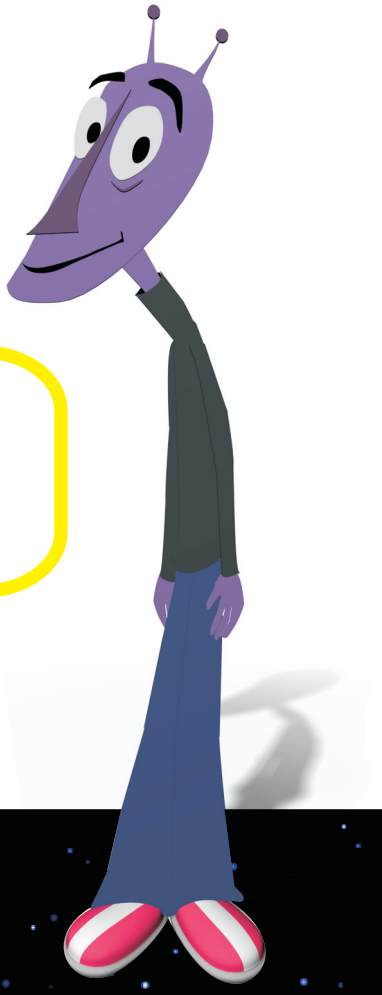
Measurement

★ Module 12 ★

Attributes and Tools

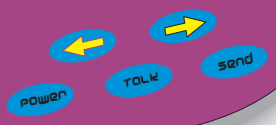


Lesson 4
Measurement: Distance

Teacher Notes 12.4

Objectives

- Solve real-world problems involving distance.
- Draw and measure distance to the nearest cm and $\frac{1}{4}$ inch, the nearest mm and $\frac{1}{8}$ inch, and the nearest mm and $\frac{1}{16}$ inch accurately.



Prerequisites

Reading and writing fractions

Converting units within the same measurement system

Vocabulary

Diameter (9.3)
Line segment (8.1)

Get Started

- Challenge students to think of as many objects as they can that can be used as a benchmark for one inch. **Possible answers: width of a thumb, diameter of a quarter, length of a paper clip, length of a match**
- Now challenge students to think of as many benchmarks as they can for one foot. **Possible answers: length of notebook page, length of football, distance from wrist to elbow, length of a person's foot**
- Repeat for centimeters and meters. **Possible answers for centimeters: width of a marker, length of a fingernail, width of a paperclip; for meters: length of a baseball bat, length of arm from fingertip to shoulder, height of doorknob above ground**

- Tell students it is useful to know the dimensions of items they regularly carry in their book bag, purse, or wallet in case they have to measure something. For instance, a dollar bill is about six inches long and a credit card is about $3\frac{1}{4}$ inches long.

Subtopic 1 — Draw and Measure Customary Distance/Length

Expand Their Horizons

In this subtopic, students learn how to read a customary ruler. Most rulers are divided into sixteenths of an inch; however, some are divided into thirty-seconds. Have rulers available for students to reference during the lesson. On most rulers, the length of each division mark is determined by which fraction of an inch they represent. The longest lines are at the inch marks, the next longest at the half-inch marks, and so on.

Some rulers have an extra space before the zero mark. This allows for wear and tear on the ruler without disturbing any measurement marks, therefore retaining accuracy in measuring. If students do come across a ruler whose zero mark has worn off, they can use the one-inch mark as the zero mark and can subtract one inch from the final measurement.

Common Error Alert:

Students whose measurements are consistently greater than the correct measurement may be aligning the object with the end of an indented ruler. Remind students to look at the end of their ruler to determine where their zero mark is before they measure. It may or may not be the very end of the ruler.

Because precision is not critical in every situation, people often round to the nearest half-inch, quarter inch, or eighth-inch. If a measurement lies directly between two choices, use the greater of the two measures. For instance, when measuring a segment that is $8\frac{3}{8}$ inches long to the nearest quarter-inch, students should round up to $8\frac{1}{2}$ inches rather than down to $8\frac{1}{4}$ inches.

Some students will come into the classroom with more experience in using a ruler than others. For students needing extra practice, teachers can set up stations around the classroom where students can measure objects to different levels of precision. Consider pairing weaker students with a partner who has more experience in using a ruler.

1 Place the ruler on the nickel so that the widest part is being measured. To give the measure to the nearest quarter-inch, determine if it is closer to the one-half mark or the three-quarter mark. It is closer to three-quarters of an inch. To the nearest sixteenth, find the closest sixteenth mark. If the ruler is divided into sixteenths, find the division line closest to the end of the nickel. The diameter is $\frac{13}{16}$ inch.

2 Draw a line segment from the zero mark on the ruler to $4\frac{5}{16}$ inch. If the ruler is divided into sixteenths, it will be five marks after the division line for four inches.

3 The fraction $8\frac{7}{16}$ is between $8\frac{6}{16}$ and $8\frac{8}{16}$. Find equivalent fractions: $8\frac{6}{16} = 8\frac{3}{8}$ and $8\frac{8}{16} = 8\frac{4}{8}$. Since $8\frac{7}{16}$ is equidistant from $8\frac{6}{16}$ and $8\frac{8}{16}$, round up to $8\frac{8}{16}$ which equals $8\frac{1}{2}$.

Additional Examples

1. Pam measured the diameter of a candle as $1\frac{7}{8}$ inches. What is the length to the nearest half inch?

The measure $1\frac{7}{8}$ inches is between $1\frac{1}{2}$ inches and two inches but closer to two inches. Therefore, $1\frac{7}{8}$ inches rounded to the nearest half inch is two inches.

2. Draw a $2\frac{11}{16}$ inch line segment.

Draw a line segment from the zero mark on the ruler to $2\frac{11}{16}$ inches. The division mark for $\frac{11}{16}$ is one mark before $\frac{3}{4}$ because $\frac{3}{4} = \frac{12}{16}$.

Subtopic 2 — Draw and Measure Metric Distance/Length

Expand Their Horizons

In this subtopic, students learn how to read a metric ruler. Students may find measuring in the metric system easier because the divisions are in tenths. Every 10 millimeters is one centimeter. While fractions could be used to give metric measurements, decimals are the norm.

Point out that 10 cm = 100 mm, so a measurement such as 12.6 cm can also be written as 12 cm 6 mm or 126 mm. Students should be comfortable reporting measurements in any of these formats.

4 Align the zero mark of the ruler with one end of the battery. The other end of the battery is between four and five centimeters but closer to five centimeters. To the nearest centimeter, it is five centimeters long. To find the length to the nearest millimeter, count the number of millimeters after four (or before five). The length is 4.7 cm, which can be written as 47 mm.

5 Draw a line segment from the zero mark on the ruler to 58 mm or 5.8 cm. It is two millimeters before six centimeters.

Additional Examples

1. **Find the length of the line segment to the nearest centimeter and millimeter.**

To the nearest centimeter, the line segment is one centimeter long because it lies between one and two centimeters but is closer to one centimeter. To the nearest millimeter, the line segment is 1.4 cm or 14 mm long.

2. **Draw a line segment 3.9 cm long.**

Draw a line segment from the zero mark on the ruler to 39 mm or 3.9 cm. It is one millimeter before four centimeters.

Subtopic 3 Problem Solving with Customary Distances

Expand Their Horizons

In this subtopic, students learn how to add and to subtract customary distances. As with solving problems with time, students will borrow and will rename units.

The lesson shows a problem involving the fencing for a square garden. In the lesson, the four sides are added. Point out that multiplication could have also been used.

$$4(4 \text{ yd } 2 \text{ ft}) = 4(4 \text{ yd}) + 4(2\text{ft}) = 16 \text{ yd} + 8 \text{ ft}$$
$$16 \text{ yd } 8\text{ft} = 16 \text{ yd} + 2 \text{ yd} + 2 \text{ ft} = 18 \text{ yd } 2 \text{ ft}$$

Common Error Alert:

When subtracting customary lengths and distances, students may regroup 10 instead of the appropriate equivalent unit of measure. Remind students if they are regrouping a foot, they are regrouping 12 inches, and if they are regrouping a yard, they are regrouping three feet or 36 inches.

6 Since Ivan is joining two lengths, the lengths should be added. Add the feet and then add the inches: 7 ft 17 in. Rename 17 in. as 1 ft 5 in. and combine this foot with the 7 ft for an answer of 8 ft 5 in.

Additional Examples

1. Athena has 4 yd 1 ft 8 in. of red ribbon, 1 yd 2 ft 7 in. of green ribbon, and 2 yd 2 ft 11 in. of blue ribbon. How much ribbon does she have in all?

Add each unit.

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  4 yd 1 ft  8 in.
  1 yd 2 ft  7 in.
+ 2 yd 2 ft 11 in.
  7 yd 5 ft 26 in.
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Change 26 in. to 2 ft 2 in. which makes the answer 7 yd 7 ft 2 in. Then, change 7 ft to 2 yd 1 ft for an answer of 9 yd 1 ft 2 in.

2. Subtract.

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  10 mi  2,355 ft
–  4 mi  4,569 ft
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Regroup one mile from the 10 miles.
1 mi = 5,280 ft.

Add it to 2,355 ft.
5,280 + 2,355 = 7,635

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  9 mi  7,635 ft
– 4 mi  4,569 ft
  5 mi  3,066 ft
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Subtopic 4 — Problem Solving with Metric Distances

Expand Their Horizons

In this subtopic, students solve problems which involve metric calculations and equivalencies. As the lesson points out, students can solve problems in centimeters and millimeters or change all the lengths to decimals.

7 Find the distance Samantha ran: 5 × 800 m = 4,000 m. Change 4,000 meters to kilometers by moving the decimal point three places to the left: 4,000 m = 4 km. Then, compare the two distances. Since 4 km > 3 km, Samantha ran farther. Alternatively, Jennifer's distance can be converted to meters by moving the decimal point three places to the right: 3 km = 3,000 m. Samantha ran 4,000 m and 4,000 m > 3,000 m, so by both methods, Samantha ran farther.

Additional Examples

1. On Monday, Juan biked 5.4 km. On Tuesday, he biked 2,758 m. On Wednesday, he biked 4 km 224 m. What distance did Juan bike in all?

Rewrite 5.4 kilometers as 5 kilometers 400 meters. Then, add.

$$\begin{array}{rr} 5 \text{ km} & 400 \text{ m} \\ & 2{,}758 \text{ m} \\ +\ 4 \text{ km} & 224 \text{ m} \\ \hline 9 \text{ km} & 3{,}382 \text{ m} \end{array}$$

Rewrite 3,382 meters as 3.382 km.

9 km + 3.382 km = 12.382 km.

Juan biked 12.382 kilometers in all. This is the same as 12,382 meters.

2. Add.

$$\begin{array}{rr} \textbf{144 cm} & \textbf{48 mm} \\ \textbf{68 cm} & \textbf{19 mm} \\ + & \textbf{87 mm} \\ \hline \end{array}$$

Add the millimeters and the centimeters.

$$\begin{array}{rr} 144 \text{ cm} & 48 \text{ mm} \\ 68 \text{ cm} & 19 \text{ mm} \\ + & 87 \text{ mm} \\ \hline 212 \text{ cm} & 154 \text{ mm} \end{array}$$

Rename 154 mm as 15 cm 4 m.

212 cm + 15 cm + 4 mm = 227 cm 4 mm or 227.4 cm.

Look Beyond

In future math and science courses, students will learn about precision, accuracy, and significant digits. The smaller the unit of measure, the more precise the measurement. Significant digits are used to tell how precise a measurement is. Students will learn rules for performing calculations with measurements that have varying degrees of precision.

Connections

Quality control managers, whether in a lab or a factory, often deal with levels of tolerance or tolerance intervals. These intervals tell how much error is allowed in a given measurement. If the length of a nail in a manufacturing plant is supposed to be two inches, quality control may determine any nail that is between $1\frac{31}{32}$ inches and $2\frac{1}{32}$ inches is acceptable.