

# 1.2 Use Segments and Congruence



**Before**

You learned about points, lines, and planes.

**Now**

You will use segment postulates to identify congruent **segments**.

**Why?**

So you can calculate flight distances, as in Ex. 33.

## Key Vocabulary

- postulate, axiom
- coordinate
- distance
- between
- congruent segments

In Geometry, a rule that is accepted without proof is called a **postulate** or **axiom**. A rule that can be proved is called a *theorem*, as you will see later. Postulate 1 shows how to find the distance between two points on a line.

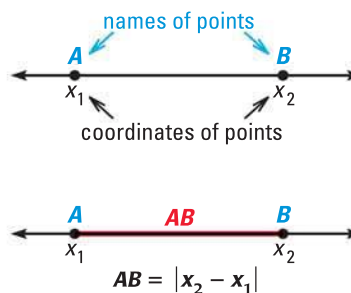
## POSTULATE

## For Your Notebook

### POSTULATE 1 Ruler Postulate

The points on a line can be matched one to one with the real numbers. The real number that corresponds to a point is the **coordinate** of the point.

The **distance** between points  $A$  and  $B$ , written as  $AB$ , is the absolute value of the difference of the coordinates of  $A$  and  $B$ .



In the diagrams above, the small numbers in the coordinates  $x_1$  and  $x_2$  are called *subscripts*. The coordinates are read as “ $x$  sub one” and “ $x$  sub two.”

The distance between points  $A$  and  $B$ , or  $AB$ , is also called the *length* of  $\overline{AB}$ .

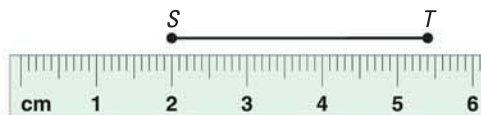
## EXAMPLE 1 Apply the Ruler Postulate

Measure the length of  $\overline{ST}$  to the nearest tenth of a centimeter.



### Solution

Align one mark of a metric ruler with  $S$ . Then estimate the coordinate of  $T$ . For example, if you align  $S$  with 2,  $T$  appears to align with 5.4.



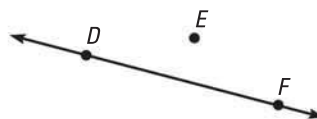
$$ST = |5.4 - 2| = 3.4 \quad \text{Use Ruler Postulate.}$$

► The length of  $\overline{ST}$  is about 3.4 centimeters.

**ADDING SEGMENT LENGTHS** When three points are collinear, you can say that one point is **between** the other two.



Point *B* is between points *A* and *C*.



Point *E* is not between points *D* and *F*.

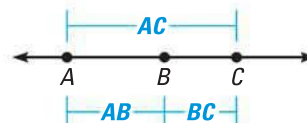
## POSTULATE

## For Your Notebook

### POSTULATE 2 Segment Addition Postulate

If *B* is between *A* and *C*, then  $AB + BC = AC$ .

If  $AB + BC = AC$ , then *B* is between *A* and *C*.



## EXAMPLE 2 Apply the Segment Addition Postulate

**MAPS** The cities shown on the map lie approximately in a straight line. Use the given distances to find the distance from Lubbock, Texas, to St. Louis, Missouri.



### Solution

Because Tulsa, Oklahoma, lies between Lubbock and St. Louis, you can apply the Segment Addition Postulate.

$$LS = LT + TS = 380 + 360 = 740$$

► The distance from Lubbock to St. Louis is about 740 miles.



### GUIDED PRACTICE for Examples 1 and 2

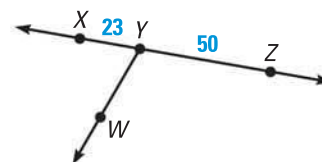
Use a ruler to measure the length of the segment to the nearest  $\frac{1}{8}$  inch.



In Exercises 3 and 4, use the diagram shown.

3. Use the Segment Addition Postulate to find  $XZ$ .

4. In the diagram,  $WY = 30$ . Can you use the Segment Addition Postulate to find the distance between points *W* and *Z*? Explain your reasoning.



### EXAMPLE 3 Find a length

Use the diagram to find  $GH$ .



**Solution**

Use the Segment Addition Postulate to write an equation. Then solve the equation to find  $GH$ .

$$FH = FG + GH \quad \text{Segment Addition Postulate}$$

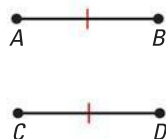
$$36 = 21 + GH \quad \text{Substitute 36 for } FH \text{ and 21 for } FG.$$

$$15 = GH \quad \text{Subtract 21 from each side.}$$

**CONGRUENT SEGMENTS** Line segments that have the same length are called **congruent segments**. In the diagram below, you can say “the length of  $\overline{AB}$  is equal to the length of  $\overline{CD}$ ,” or you can say “ $\overline{AB}$  is congruent to  $\overline{CD}$ .” The symbol  $\cong$  means “is congruent to.”

#### READ DIAGRAMS

In the diagram, the red tick marks indicate that  $\overline{AB} \cong \overline{CD}$ .



Lengths are equal.

$$AB = CD$$

“is equal to”

Segments are congruent.

$$\overline{AB} \cong \overline{CD}$$

“is congruent to”

### EXAMPLE 4 Compare segments for congruence

Plot  $J(-3, 4)$ ,  $K(2, 4)$ ,  $L(1, 3)$ , and  $M(1, -2)$  in a coordinate plane. Then determine whether  $\overline{JK}$  and  $\overline{LM}$  are congruent.

**Solution**

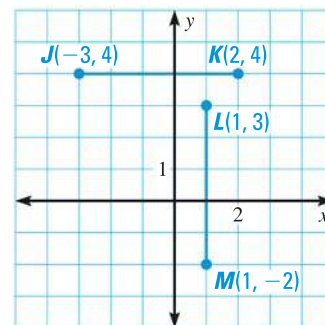
To find the length of a horizontal segment, find the absolute value of the difference of the  $x$ -coordinates of the endpoints.

$$JK = |2 - (-3)| = 5 \quad \text{Use Ruler Postulate.}$$

To find the length of a vertical segment, find the absolute value of the difference of the  $y$ -coordinates of the endpoints.

$$LM = |-2 - 3| = 5 \quad \text{Use Ruler Postulate.}$$

►  $\overline{JK}$  and  $\overline{LM}$  have the same length. So,  $\overline{JK} \cong \overline{LM}$ .



#### REVIEW USING A COORDINATE PLANE

For help with using a coordinate plane, see p. 878.



#### GUIDED PRACTICE for Examples 3 and 4

- Use the diagram at the right to find  $WX$ .
- Plot the points  $A(-2, 4)$ ,  $B(3, 4)$ ,  $C(0, 2)$ , and  $D(0, -2)$  in a coordinate plane. Then determine whether  $\overline{AB}$  and  $\overline{CD}$  are congruent.



# 1.2 EXERCISES

## HOMWORK KEY


 = **WORKED-OUT SOLUTIONS**  
on p. WS1 for Exs. 13, 17, and 33  
 = **STANDARDIZED TEST PRACTICE**  
Exs. 2, 20, 27, and 34

### SKILL PRACTICE

 In Exercises 1 and 2, use the diagram at the right.

1. **VOCABULARY** Explain what  $\overline{MN}$  means and what  $MN$  means.



2.  **WRITING** Explain how you can find  $PN$  if you know  $PQ$  and  $QN$ . How can you find  $PN$  if you know  $MP$  and  $MN$ ?


#### EXAMPLE 1

on p. 9  
for Exs. 3–5

**MEASUREMENT** Measure the length of the segment to the nearest tenth of a centimeter.

3. 

4. 

5. 

#### EXAMPLES 2 and 3

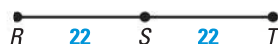
on pp. 10–11  
for Exs. 6–12

**SEGMENT ADDITION POSTULATE** Find the indicated length.

6. Find  $MP$ .



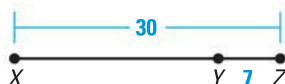
7. Find  $RT$ .



8. Find  $UW$ .



9. Find  $XY$ .



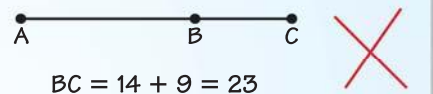
10. Find  $BC$ .



11. Find  $DE$ .




12. **ERROR ANALYSIS** In the figure at the right,  $AC = 14$  and  $AB = 9$ . Describe and correct the error made in finding  $BC$ .



#### EXAMPLE 4

on p. 11  
for Exs. 13–19

**CONGRUENCE** In Exercises 13–15, plot the given points in a coordinate plane. Then determine whether the line segments named are congruent.

13.   $A(0, 1), B(4, 1), C(1, 2), D(1, 6)$ ;  $\overline{AB}$  and  $\overline{CD}$

14.  $J(-6, -8), K(-6, 2), L(-2, -4), M(-6, -4)$ ;  $\overline{JK}$  and  $\overline{LM}$

15.  $R(-200, 300), S(200, 300), T(300, -200), U(300, 100)$ ;  $\overline{RS}$  and  $\overline{TU}$

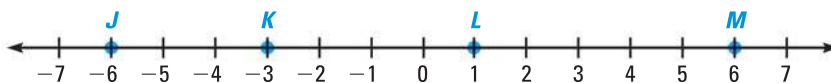
 **ALGEBRA** Use the number line to find the indicated distance.

16.  $JK$

17.   $JL$

18.  $JM$

19.  $KM$

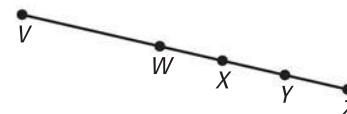


 20.  **SHORT RESPONSE** Use the diagram. Is it possible to use the Segment Addition Postulate to show that  $FB > CB$  or that  $AC > DB$ ? Explain.



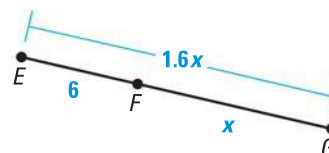
**FINDING LENGTHS** In the diagram, points  $V, W, X, Y,$  and  $Z$  are collinear,  $VZ = 52, XZ = 20,$  and  $WX = XY = YZ$ . Find the indicated length.

21.  $WX$                       22.  $VW$                       23.  $WY$   
24.  $VX$                       25.  $WZ$                       26.  $VY$



27. **★ MULTIPLE CHOICE** Use the diagram.  
What is the length of  $\overline{EG}$ ?

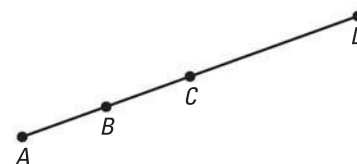
- (A) 1                      (B) 4.4  
(C) 10                      (D) 16



**xy ALGEBRA** Point  $S$  is between  $R$  and  $T$  on  $\overline{RT}$ . Use the given information to write an equation in terms of  $x$ . Solve the equation. Then find  $RS$  and  $ST$ .

28.  $RS = 2x + 10$                       29.  $RS = 3x - 16$                       30.  $RS = 2x - 8$   
 $ST = x - 4$                        $ST = 4x - 8$                        $ST = 3x - 10$   
 $RT = 21$                        $RT = 60$                        $RT = 17$

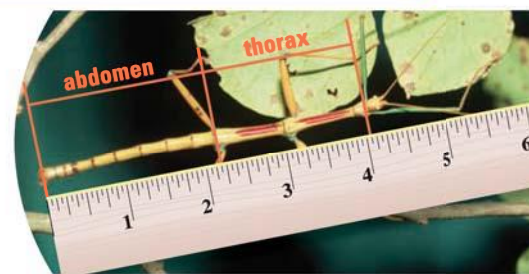
31. **CHALLENGE** In the diagram,  $\overline{AB} \cong \overline{BC}$ ,  $\overline{AC} \cong \overline{CD}$ , and  $AD = 12$ . Find the lengths of all the segments in the diagram. Suppose you choose one of the segments at random. What is the probability that the measure of the segment is greater than 3? *Explain.*



## PROBLEM SOLVING

32. **SCIENCE** The photograph shows an insect called a walkingstick. Use the ruler to estimate the length of the abdomen and the length of the thorax to the nearest  $\frac{1}{4}$  inch. About how much longer is the walkingstick's abdomen than its thorax?

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### EXAMPLE 2

on p. 10  
for Ex. 33

33. **MODEL AIRPLANE** In 2003, a remote-controlled model airplane became the first ever to fly nonstop across the Atlantic Ocean. The map shows the airplane's position at three different points during its flight.



- A** Leave Cape Spear, Newfoundland  
**B** Approximate position after about 1 day  
**C** Land at Mannin Bay, Ireland, after nearly 38 hours

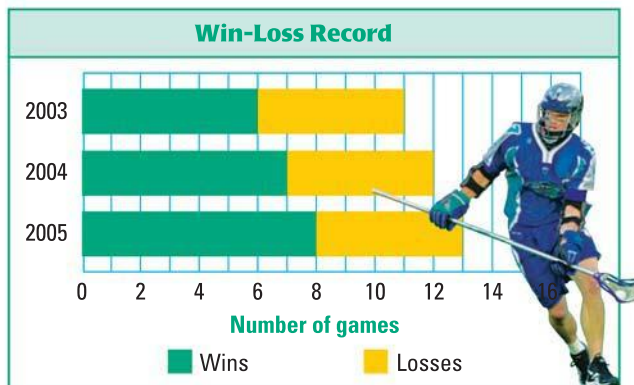
- a. Find the total distance the model airplane flew.  
b. The model airplane's flight lasted nearly 38 hours. Estimate the airplane's average speed in miles per hour.

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34. ★ **SHORT RESPONSE** The bar graph shows the win-loss record for a lacrosse team over a period of three years.

- Use the scale to find the length of the yellow bar for each year. What does the length represent?
- For each year, find the percent of games lost by the team.
- Explain* how you are applying the Segment Addition Postulate when you find information from a stacked bar graph like the one shown.



35. **MULTI-STEP PROBLEM** A climber uses a rope to descend a vertical cliff. Let  $A$  represent the point where the rope is secured at the top of the cliff, let  $B$  represent the climber's position, and let  $C$  represent the point where the rope is secured at the bottom of the cliff.
- Model** Draw and label a line segment that represents the situation.
  - Calculate** If  $AC$  is 52 feet and  $AB$  is 31 feet, how much farther must the climber descend to reach the bottom of the cliff?

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36. **CHALLENGE** Four cities lie along a straight highway in this order: City A, City B, City C, and City D. The distance from City A to City B is 5 times the distance from City B to City C. The distance from City A to City D is 2 times the distance from City A to City B. Copy and complete the mileage chart.

	City A	City B	City C	City D
City A		?	?	?
City B	?		?	?
City C	?	?		10 mi
City D	?	?	?	

## MIXED REVIEW

### PREVIEW

Prepare for  
Lesson 1.3  
in Exs. 37–42.

**Simplify the expression. Write your answer in simplest radical form. (p. 874)**

37.  $\sqrt{45 + 99}$

38.  $\sqrt{14 + 36}$

39.  $\sqrt{42 + (-2)^2}$

**Solve the equation. (p. 875)**

40.  $4m + 5 = 7 + 6m$

41.  $13 - 4h = 3h - 8$

42.  $17 + 3x = 18x - 28$

**Use the diagram to decide whether the statement is *true* or *false*. (p. 2)**

43. Points  $A$ ,  $C$ ,  $E$ , and  $G$  are coplanar.

44.  $\overleftrightarrow{DF}$  and  $\overleftrightarrow{AG}$  intersect at point  $E$ .

45.  $\overrightarrow{AE}$  and  $\overrightarrow{EG}$  are opposite rays.

