Table of Contents ⊕) (?) Section Page <<< < Page 1 of 7



Segment Bisectors

Full Page View

(日)

Goal

Bisect a segment. Find the coordinates of the midpoint of a segment.

Key Words

- midpoint
- segment bisector
- bisect



In the Geo-Activity, *M* is called the *midpoint* of *AB*. The **midpoint** of a segment is the point on the segment that divides it into two congruent segments.



So, bisect means "to cut in two."

A **segment bisector** is a segment, ray, line, or plane that intersects a segment at its midpoint. To **bisect** a segment means to divide the segment into two congruent segments.



 \overrightarrow{CD} is a bisector of \overrightarrow{AB} .



EXAMPLE 1 Find Segment Lengths

M is the midpoint of \overline{AB} . Find *AM* and *MB*.



Solution

M is the midpoint of \overline{AB} , so *AM* and *MB* are each half the length of \overline{AB} .

$$AM = MB = \frac{1}{2} \cdot AB = \frac{1}{2} \cdot 26 = 13$$

ANSWER AM = 13 and MB = 13.

EXAMPLE 2 Find Segment Lengths

P is the midpoint of \overline{RS} . Find *PS* and *RS*.



Solution

P is the midpoint of \overline{RS} , so PS = RP. Therefore, PS = 7. You know that *RS* is twice the length of \overline{RP} .

 $RS = 2 \cdot \mathbf{RP} = 2 \cdot \mathbf{7} = 14$

ANSWER \triangleright *PS* = 7 and *RS* = 14.

Chackpoint V Find Segment Lengths

1. Find *DE* and *EF*.









EXAMPLE 3 Use Algebra with Segment Lengths

Line ℓ is a segment bisector of \overline{AB} . Find the value of *x*.



Solution

AM = MB Line ℓ bisects \overline{AB} at point M.

- 5x = 35 Substitute 5x for AM and 35 for MB.
- $\frac{5x}{5} = \frac{35}{5}$ Divide each side by 5.

$$x = 7$$
 Simplify.

CHECK \checkmark Check your solution by substituting 7 for *x*.

5x = 5(7) = 35

Midpoints If you know the coordinates of the endpoints of a line segment in a coordinate plane, you can find the coordinates of the midpoint of the segment using the Midpoint Formula.

THE MIDPOINT FORMULA



EXAMPLE 4 Use the Midpoint Formula

Find the coordinates of the midpoint of \overline{AB} .

a. *A*(1, 2), *B*(7, 4)

b. A(-2, 3), B(5, -1)

Solution

First make a sketch. Then use the Midpoint Formula.





$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$
$$= \left(\frac{-2 + 5}{2}, \frac{3 + (-1)}{2}\right)$$
$$= \left(\frac{3}{2}, 1\right)$$



Sketch \overline{PQ} . Then find the coordinates of its midpoint.

3. *P*(2, 5), *Q*(4, 3)

4. *P*(0, −2), *Q*(4, 0)

5. *P*(-1, 2), *Q*(-4, 1)

Student Help Skills Review For help plotting points in a coordinate plane, see p. 664.

Student Help

The numbers 1 and 2 in

subscripts. You read x_1 as "x sub 1" and y_2 as

"y sub 2."••••••

 x_1 and y_2 are called

READING TIP

Section

Page

<

Page 4 of 7

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48



2.1 Exercises

Guided Practice

Vocabulary Check

1. In the diagram shown at the right, name the *midpoint* and a *segment bisector* of *AB*.

Full Page View

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Skill Check

- *M* is the midpoint of the segment. Find the segment lengths.
 - **2.** Find *RM* and *MS*.





M is the midpoint of \overline{JK} . Find the value of the variable.

• K





Find the coordinates of the midpoint of \overline{PR} .



Practice and Applications

Extra Practice

See p. 677.

Recognizing Midpoints In Exercises 11–14, determine whether M is the midpoint of \overline{AB} . Explain your reasoning.



15. Visualize It: Sketch a line segment, \overline{PQ} , that is bisected by line ℓ at point *R*.

	Full Page View	Section	Page		Page Section
Go to classzone.com Table of Contents			<	Page 5 of 7	

	Homework Help				
2	Example 1:	Exs. 16–19			
	Example 2:	Exs. 20-23			
	Example 3:	Exs. 26–29			
	Example 4:	Exs. 30–35			

Finding Segment Lengths *M* is the midpoint of the segment. Find the segment lengths.



Finding Segment Lengths Line ℓ bisects the segment. Find the segment lengths.



Biking The Minuteman Bikeway is a 10.5 mile bike path that runs from Arlington to Bedford, Massachusetts.

- **24.** Caitlin and Laurie begin at opposite ends of the Minuteman Bikeway and meet at the halfway point on the path. How far does each rider bike?
- **25.** Caitlin starts on the path 4.3 miles from the Arlington end. Laurie starts on the path 3 miles from the Bedford end. How far will each rider bike before reaching the halfway point on the path?





Extra help with problem solving in Exs. 30–35 is at classzone.com



Strike Zone In Exercises 36 and 37, use the information below.

Full Page View

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In baseball, the *strike zone* is the region a baseball needs to pass through for the umpire to declare it a strike if the batter does not swing. The top of the strike zone is a horizontal plane passing through the midpoint of the top of the batter's shoulders and the top of the uniform pants when the player is in a batting stance.

Source: Major League Baseball

36. Find the coordinate of *T*.

⊕ (Q)

37. Find the coordinate of *T*.

Section

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Page

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Page 6 of 7

Section

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Page





Student Help

EXAMPLE Latitude-Longitude Coordinates

Find the coordinates of the place halfway between San Francisco (37.8°N, 122.4°W) and Los Angeles (34.1°N, 118.2°W).

Solution

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$
$$= \left(\frac{37.8^\circ + 34.1^\circ}{2}, \frac{122.4^\circ + 118.2}{2}\right)$$
$$= (35.95^\circ \text{N}, 120.3^\circ \text{W})$$



ANSWER The place halfway between San Francisco and Los Angeles has coordinates (35.95°N, 120.3°W).

Latitude-Longitude Coordinates Find the coordinates of the place halfway between the two cities in California.

- **38.** Fresno: (36.7°N, 119.8°W) Napa: (38.3°N, 122.3°W)
- **39.** Bishop: (37.4°N, 118.4°W) Los Angeles: (34.1°N, 118.2°W)
- **40.** San Francisco: (37.8°N, 122.4°W) **41.** Santa Barbara: (34.4°N, 119.7°W) Palo Alto: (37.4°N, 122.1°W)
 - Oakland: (37.8°N, 122.3°W)

VOCABULARY TIP Lines of *latitude* run

parallel to the Equator. Lines of *longitude* run north-south.



58

Full Page View

(日)

Section Page Page Section

42. Using Midpoints In the diagram below, *B* is the midpoint of \overline{AC} , AB = 9, and AD = 25. Find *CD*.



43. Challenge The midpoint of \overline{AB} is M(7, 5). The coordinates of point *A* are (4, 1). Find the coordinates of point *B*. Explain.

Standardized Test Practice **44.** Multiple Choice *T* is the midpoint of \overline{QR} . What is the value of *x*? (A) 17 (B) 22 (A) $\overline{A} = 10$ (I) $\overline{I} = 78$ (B) $\overline{R} = 10$ (I) $\overline{R} = 10$

45. Multiple Choice What is the midpoint of the segment joining (2, 7) and (-6, 2)?

(F)
$$\left(-2, \frac{9}{2}\right)$$
 (G) $(-4, 9)$ **(H)** $(-2, 4)$ **(J)** $\left(\frac{9}{2}, -2\right)$

Mixed Review Evaluating Statements Use the diagram at the right to determine whether the statement is *true* or *false*. (Lessons 1.3, 1.5)

D 88

46. Point *A* lies on line *m*.

(C) 29.5

- **47.** Point *E* lies on line ℓ .
- **48.** Points *B*, *E*, and *C* are collinear.
- **49.** Lines l and m intersect at point E.
- **50.** Point *E* is between points *B* and *C*.
- **51.** Point *F* is between points *A* and *B*.

Classifying Angles Name the vertex and sides of the angle. Then state whether it appears to be *acute, right, obtuse,* or *straight*. (Lesson 1.6)



Algebra Skills

Evaluating Expressions Evaluate the expression.

(Skills Review, p. 670)

55. 2 • 15 + 40	56. 120 − 35 • 3	57. $\frac{1}{2} \cdot 50 + 145$
58. $\frac{5}{4} \cdot 16 - 20$	59. 6 + 3 • 5 − 2	60. 11 • 4 + 7 − 20
61. 12 • 2 - 3 • 4	62. 5 − 10 • 6 + 1	63. 2 - (3 + 4) • 5