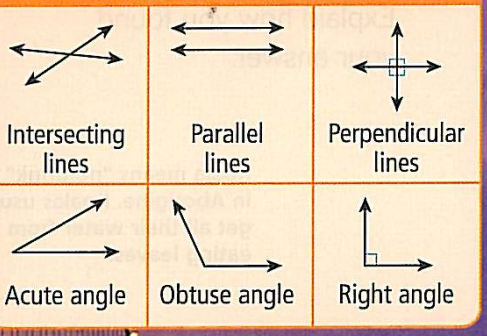
CHAPTER 17

Lines, Rays, and Angles

FAST FACT • SOCIAL STUDIES The Ambassador Bridge, between Detroit, Michigan, and Windsor, Ontario, Canada, is the busiest border crossing in North America. About 7,000 trucks cross it each day.

PROBLEM SOLVING Tell what kind of lines and angles you see in the photograph of the bridge.

TYPES OF LINES AND ANGLES

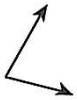


CHECK WHAT YOU KNOW

Use this page to help you review and remember important skills needed for Chapter 17.

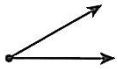
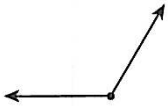
IDENTIFY GEOMETRIC FIGURES

Write the name of each figure.

1.
2.
3.
4. 
5. 
6. 

IDENTIFY ANGLES

Tell if each angle is a *right* angle, *greater than* a right angle, or *less than* a right angle.

7. 
8. 
9. 
10. 
11. 
12. 

VOCABULARY POWER

REVIEW

geometry [jē•ä′mə•trē] *noun*

Geometry comes from the Greek word for *Earth, Geos*, and from the Greek term, *metros,* "to measure." So, *geometry* means "to measure the Earth." In your own words, tell what the study of geometry includes.

PREVIEW

point	degree (°)
line	right angle
line segment	acute angle
ray	obtuse angle
plane	straight angle
angle	intersecting lines
vertex	parallel lines
protractor	perpendicular lines

GO ON-LINE www.harcourtschool.com/mathglossary

LESSON 1

Lines and Rays

Quick Review

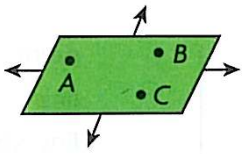
1. $96 \div 9$
2. $115 \div 33$
3. $643 \div 50$
4. $406 \div 20$
5. $118 \div 25$

VOCABULARY

point **ray**
line **plane**
line segment

Learn

GEOMETRY EVERYWHERE! Everywhere you look, you can see points, lines, and rays in nature and in things people make. You can use the following geometric ideas and terms to describe the world around you.

Term and Definition	Draw It	Read It	Write It
A **point** names an exact location in space.	• A	point A	point A
A **line** is a straight path of points that continues without end in both directions. It has no endpoints.	K ⟷ L	line KL	$\overleftrightarrow{KL}$
A **line segment** is part of a line. It has two endpoints and all the points between them. It is the shortest distance between two points.	K — L	line segment KL	$\overline{KL}$
A **ray** is part of a line. It has one endpoint and continues without end in one direction.	K ⟶ L	ray KL	$\overrightarrow{KL}$
A **plane** is a flat surface of points that continues without end in all directions. A plane is named by at least three points in the plane.		plane ABC	plane ABC

- Find as many examples of these terms as you can in the photograph. Describe how the definitions of the terms match the figures.

Check

1. **Give** some examples of line segments that you see in your classroom.

Name a geometric term that describes each.

2. side edge of a door
3. sharp tip of a pencil
4. laser beam

Practice and Problem Solving

Extra Practice, page 374, Set A

Name a geometric term that describes each.

5. flagpole
6. parking lot
7. tip of a tack

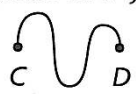
Draw and label an example of each.

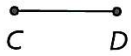
8. line BC
9. line segment PQ
10. point G
11. plane RST
12. line ST
13. ray XY

Draw each line segment with the given length.

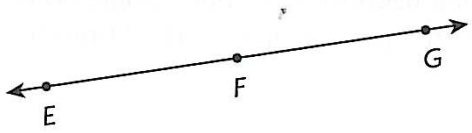
14. $\overline{BC}$, 3 cm
15. $\overline{AE}$, 2 in.
16. $\overline{JK}$, $3\frac{1}{2}$ in.
17. $\overline{RS}$, 6 cm

18. **REASONING** Which path is the shortest distance between point C and point D? Explain how you know.

a. 

b. 

19. Write all the names for the line below.



20. For lunch each day, Mia buys a hot meal for \$1.75 and milk for \$0.50. What is the least number of \$1 bills that her mother can give her so she will have enough lunch money for 5 days?

21. Name a geometric term that describes the floor of your classroom.

22. **Write About It** Explain the differences between a line, a ray, and a line segment.

Technology Link

More Practice: Harcourt Mega Math Ice Station Exploration, *Polar Planes*, Level A

Mixed Review and Test Prep

23. $500 - 490$ (p. 48)
24. $703 - 585$ (p. 48)
25. $6{,}435 + 797 + 285$ (p. 48)
26. Is 15 prime or composite? (p. 342)

27. **TEST PREP** What is the value of the blue digit in 45,678,342? (p. 6)

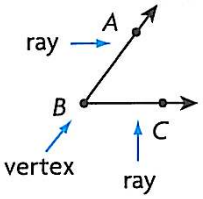
A 800
B 8,000
C 80,000
D 800,000

LESSON 2

Measure and Classify Angles

Learn

FROM EVERY ANGLE Two rays with the same endpoint form an **angle**. The endpoint is called the **vertex**.

Draw It	Read It	Write It
	angle *ABC* angle *CBA* angle *B*	$\angle ABC$ $\angle CBA$ $\angle B$

NOTE: The vertex is always the middle letter or the single letter that names the angle.

A **protractor** is a tool used to measure the size of an angle. The unit used for measuring angles is a **degree (°)**. The scale on a protractor is marked from 0° to 180°.

Quick Review

List the factors for each product.

1. 14 **2.** 25
3. 27 **4.** 12
5. 29

VOCABULARY

angle
vertex
protractor
degree (°)
right angle
acute angle
obtuse angle
straight angle

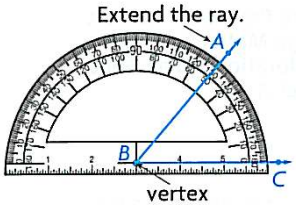
HANDS ON

Activity **MATERIALS:** protractor

Use a protractor to measure angle *ABC*.

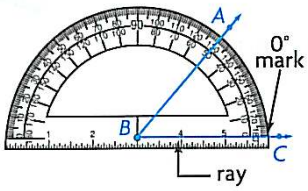
STEP 1

Place the center of the protractor on the vertex of the angle.



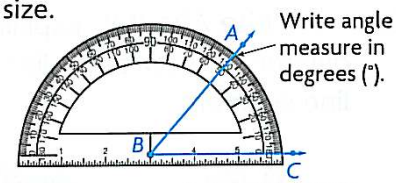
STEP 2

Line up the center point and the 0° mark on the protractor with one ray of the angle.



STEP 3

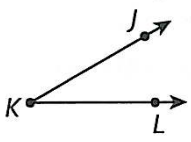
Read the measure of the angle where the other ray passes through the scale. Use the scale that makes sense for the angle size.



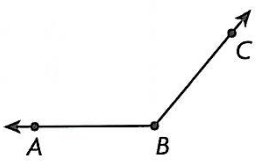
The measure of $\angle ABC = 50°$.

- Trace each angle. Then use a protractor to measure the angle.

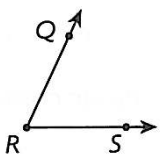
a.



b.



c.

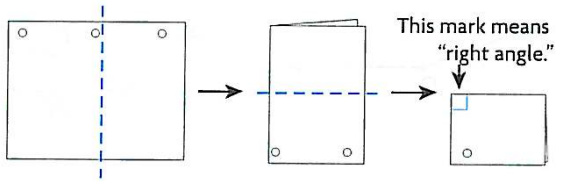


Types of Angles

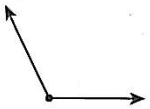
HANDS ON

Activity **MATERIALS:** paper

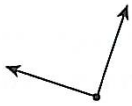
Make an angle using a sheet of paper. Fold the paper twice to make an angle like this. The angle you made is called a right angle.

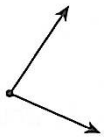


Use the right angle you made to find out which of the following are also right angles. Write *yes* or *no*.

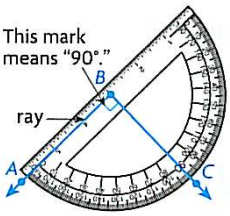
a. 

b. 

c. 

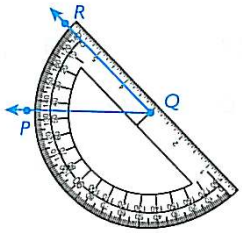
d. 

An angle can be classified according to the size of the opening between its rays.



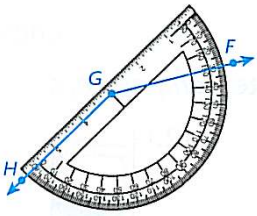
The measure of $\angle B = 90°$.

A **right angle** measures 90°. A right angle forms a square corner.



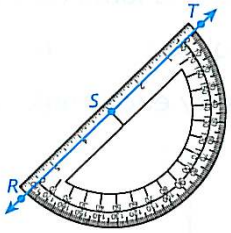
The measure of $\angle Q = 45°$.

An **acute angle** measures greater than 0° and less than 90°.



The measure of $\angle G = 150°$.

An **obtuse angle** measures greater than 90° and less than 180°.



The measure of $\angle S = 180°$.

A **straight angle** measures 180°. A straight angle forms a line.

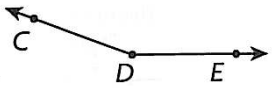
- Find as many examples as you can of each type of angle in the painting *Three Musicians* by Pablo Picasso. You may trace the angle and use a protractor to measure it.
- Do you always need a protractor to determine whether an angle is acute, obtuse, right, or straight? Explain.

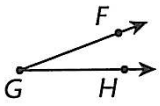
LESSON CONTINUES

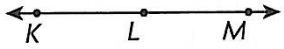
Check

1. **Draw** a picture of an object that has a right angle, an acute angle, and a straight angle. Label each angle.

Trace each angle. Use a protractor to measure the angle. Then write *acute*, *obtuse*, *right*, or *straight*.

2. 

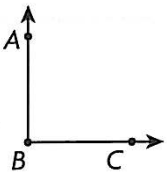
3. 

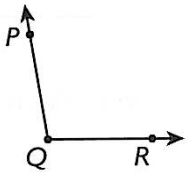
4. 

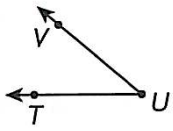
Practice and Problem Solving

Extra Practice, page 374, Set B

Trace each angle. Use a protractor to measure the angle. Then write *acute*, *obtuse*, *right*, or *straight*.

5. 

6. 

7. 

Draw and label an example of each.

8. obtuse angle *RST*

9. acute angle *JKL*

10. right angle *E*

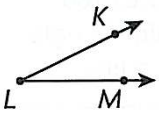
Classify each angle. Write *right*, *acute*, *obtuse*, or *straight*.

11. 

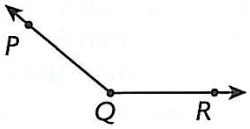
12. 

13. 

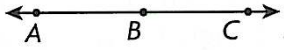
Write the letter of the phrase that best describes each angle.

14. 

a. less than 45°
b. greater than 90°

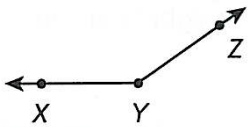
15. 

a. less than 180°
b. less than 90°

16. 

a. less than 45°
b. equal to 180°

17. Look at the figure below. Name the figure three different ways.



18. **What's the Error?** Wanda said that the letter *W* has two angles. What error did she make?

W

19. **REASONING** Use the corner of a sheet of paper to prove or disprove that the three angles in the letter *M* are right angles.

20. Give a time when the hands on a clock represent each type of angle: acute, obtuse, right, and straight.

21. Suchada spent $15 at the gift shop. Later her father gave her $10 to buy lunch, but she only spent $7. At the end of the day, Suchada had $10. How much money did she have at the beginning of the day?

22. **Vocabulary Power** You use a *scale* to measure weight. Compare and contrast a scale for weight with a protractor scale. How are they alike? How are they different?

Mixed Review and Test Prep

23. $(3 + 4) \times 2$ (p. 184)

24. $1{,}400 \div 2$ (p. 288)

25. $\square \div 8 = 16$ (p. 300)

26. $900 \div 3$ (p. 288)

27. Kim opened a carton of 12 eggs. She put 4 eggs in each of 2 bowls. How many eggs were left in the carton? Write the expression you used. (p. 184)

28. **TEST PREP** What is 745,864 rounded to the nearest ten thousand? (p. 30)

A 700,000 C 745,000
B 740,000 D 750,000

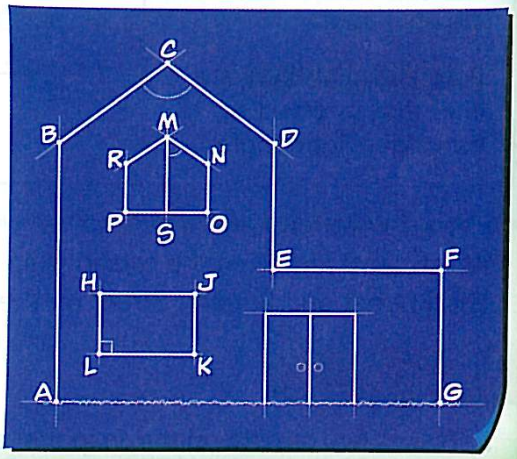
29. **TEST PREP** It takes Pam 40 minutes to walk home from school. If she left school at 11:45 A.M., what time would she get home? (p. 98)

F 12:10 P.M. H 12:25 P.M.
G 12:20 P.M. J 12:45 P.M.

Problem Solving LINKUP . . . to Art

When architects design houses or buildings, they draw different views by using points, planes, line segments, and angles.

This drawing shows only the front view of a building.



Use the drawing and give an example of each of the following.

1. line segment
2. right angle
3. obtuse angle
4. acute angle
5. point
6. plane

LESSON 3

Line Relationships

Quick Review

Write *prime* or *composite*.

1. 17
2. 6
3. 31
4. 45
5. 22

VOCABULARY

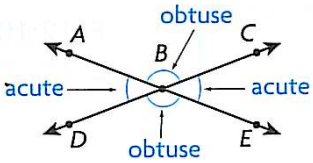
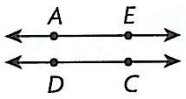
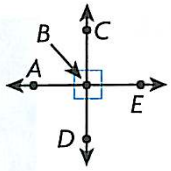
intersecting lines

parallel lines

perpendicular lines

Learn

FOLLOW THE LINES Look at the term and definition for each line relationship. Find these same relationships on the road map.

Term and Definition	Draw It	Read It	Write It
Intersecting lines are lines that cross each other at exactly one point. They form four angles.		Line *AE* intersects line *DC* at point *B*.	$\overleftrightarrow{AE}$ intersects $\overleftrightarrow{DC}$ at point *B*.
Parallel lines are lines in the same plane that never intersect and are always the same distance apart.		Line *AE* is parallel to line *DC*.	$\overleftrightarrow{AE} \parallel \overleftrightarrow{DC}$
Perpendicular lines are lines that intersect to form four right angles.		Line *AE* is perpendicular to line *DC*.	$\overleftrightarrow{AE} \perp \overleftrightarrow{DC}$

- Which term identifies the relationship between Third Street and Second Street on the map?

Technology Link

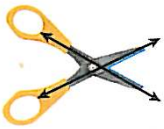
More Practice: Harcourt Mega Math Ice Station Exploration, *Polar Planes*, Level C

Check

1. **Name** two streets on the map that are perpendicular. Name two streets that are intersecting and not perpendicular.

Name any line relationship you see in each figure. Write *intersecting, parallel,* or *perpendicular.*

2. 

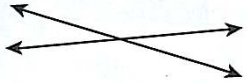
3. 

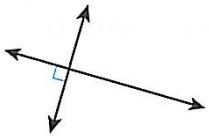
4. 

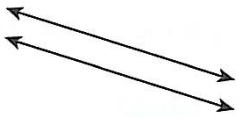
Practice and Problem Solving

Extra Practice, page 374, Set C

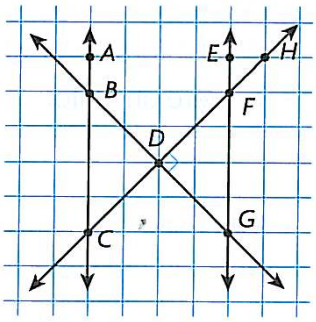
Name any line relationship you see in each figure. Write *intersecting, parallel,* or *perpendicular.*

5. 

6. 

7. 

For 8–14, use the drawing at the right.



8. Name a right angle.

9. Name two parallel lines.

10. Name an acute angle.

11. Name an obtuse angle.

12. Name four line segments that include point *G*.

13. Name two intersecting lines.

14. Name two perpendicular lines.

Use grid paper to draw each line relationship.

15. perpendicular lines

16. parallel lines

17. intersecting lines

18. The product of two numbers is 45. Their sum is 18. What are the numbers?

19. **Write About It** Explain how you can tell the difference between intersecting lines and parallel lines.

20. **REASONING** Is this statement true or false? "Perpendicular lines are also intersecting lines." Explain your answer.

21. **What's the Error?** Tricia said that all intersecting lines are perpendicular. Explain her error. Include a drawing with your explanation.

Mixed Review and Test Prep

22. 542×6 (p. 222)

23. $804 \div 5$ (p. 302)

24. What are the two missing numbers in the pattern? (p. 346)
20, 18, 16, ■, 12, 10, ■, 6

25. $96{,}784 + 8{,}400$ (p. 52)

26. **TEST PREP** In what place is the 9 in 3,902,817? (p. 6)

A thousands **C** hundred thousands
B ten thousands **D** millions

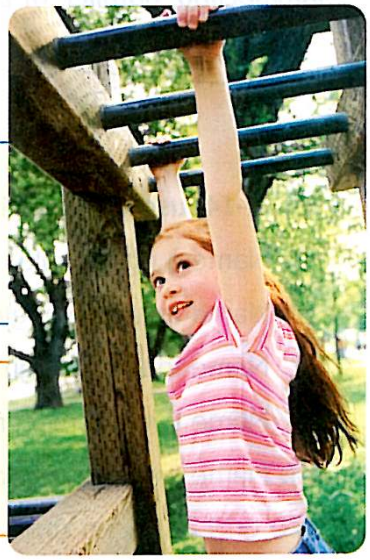
LESSON 4

Problem Solving Strategy
Draw a Diagram

Quick Review

1. 12 + 18 + 9
2. 19 + 21 + 6
3. 8 + 24 + 8
4. 10 + 15 + 23
5. 22 + 8 + 11 + 6

PROBLEM Fairglen Elementary is planning an obstacle course for the school fair. The course will start on the south side of the playground. From the starting point, the course goes 7 units north to the slide. Then it goes 7 units east and 4 units south to the swing set. From the swing set, the course continues 4 units west, 2 units south, and 6 units west to the jungle gym. How long is the course when it crosses its own path?



UNDERSTAND

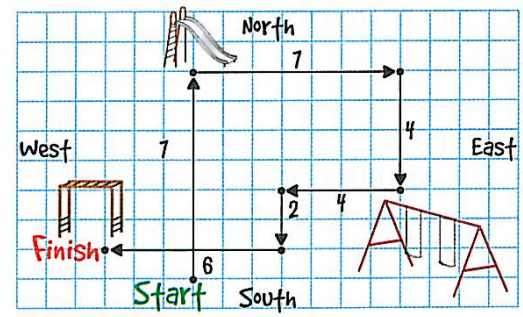
- What are you asked to find?
- What information will you use?
- Is there any information you will not use? If so, what?

PLAN

- What strategy can you use to solve the problem?
  You can *draw a diagram* to show a map of the obstacle course.

SOLVE

- How can you draw a diagram?
  You can use grid paper. Label your grid *North*, *East*, *South*, and *West*. Follow the directions. Draw line segments to show the course. Label the distances and locations. Then add the units along the path until the path crosses itself.



So, the obstacle course is 27 units long when it crosses its own path.

CHECK

- How can you check your answer?

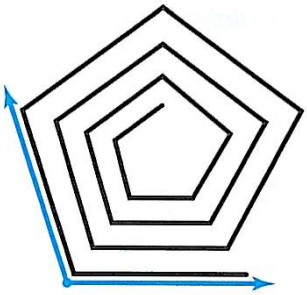
Problem Solving Practice

1. **What if** the obstacle course continues from the finish line 3 units north, 7 units east, and then 4 units north? How long is the course when it crosses its own path a third time?

2. Suppose you were given these directions to a museum. On Main Street, go north for 28 miles. Turn right on Highway 33 and go east for 187 miles. How many miles will you travel to the museum?

FAST FACT • SOCIAL STUDIES **About one-third of the 1,500 labyrinths in the United States were built in the year 2000. Unlike mazes, labyrinths are walking paths with no dead ends. Study the path of the labyrinth drawing.**

3. How many line segments can you find in the labyrinth from start to finish?



   A 10 line segments
   B 14 line segments
   C 15 line segments
   D 18 line segments

4. What kind of angle is shown by the line segments in the labyrinth?

   F acute angle
   G obtuse angle
   H right angle
   J scalene angle

Strategies

- **Draw a Diagram or Picture**
- Make a Model or Act It Out
- Make an Organized List
- Find a Pattern
- Make a Table or Graph
- Predict and Test
- Work Backward
- Solve a Simpler Problem
- Write an Equation
- Use Logical Reasoning

Problem Solving

▲ **The labyrinth at Forestheart Studios, Woodsboro, Maryland, is about 560 feet long.**

Mixed Strategy Practice

5. If Carrie takes one guitar lesson a week, how much will it cost, including book rental, to take four lessons at the store?

Guitar Lesson Fees

1 Lesson	Cost	Book Rental
At home	$10.00	No charge
At store	$7.00	$0.50/week

6. Mr. Ross designs mazes. He made 2 mazes the first week, 3 the second week, and 5 the third week. If Mr. Ross continues this pattern, how many mazes will he make during the fourth week?

7. Zack is showing his brother 90° by using the hour and minute hands on a clock. Name some times he can use to show 90° on a clock.

CHAPTER 17

Extra Practice

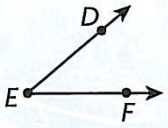
Set A (pp. 364–365)

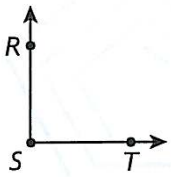
Draw and label an example of each.

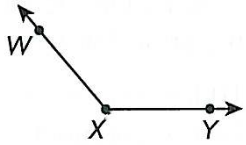
1. line segment *DC*
2. point *J*
3. ray *JK*
4. plane *RST*
5. line segment *AB*
6. line *GH*
7. Give some examples of lines that you see every day.
8. Name an object in your classroom that is like a line segment.

Set B (pp. 366–369)

Trace each angle. Use a protractor to measure the angle. Then write *acute*, *obtuse*, *right*, or *straight*.

1. 

2. 

3. 

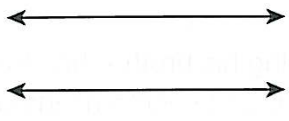
Draw and label an example of each.

4. obtuse angle *MNP*
5. acute angle *B*
6. straight angle *DEF*
7. The limbs of a tree form angles with the trunk of the tree. Classify angles *A* and *B* in this tree as *acute*, *obtuse*, or *right*.

8. The measure of $\angle XYZ$ is an odd number. The sum of the two digits is 12. The tens digit is 2 greater than the ones digit. What is the measure of $\angle XYZ$?

Set C (pp. 370–371)

Name any line relationship you see in each figure. Write *intersecting*, *parallel*, or *perpendicular*.

1. 
2. 
3.