

Segments, Rays, Parallel Lines and Planes

What You'll Learn

- Relating segments and rays to lines
- Recognizing parallel lines and parallel planes

...And Why

To provide a vocabulary of terms needed for communicating in geometry

What You'll Need

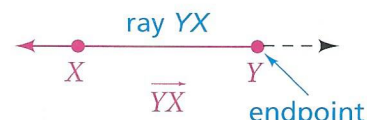
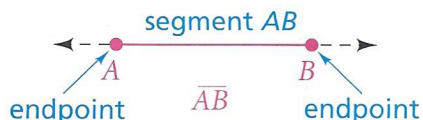
graph paper, colored pencils, tape

THINK AND DISCUSS

Many geometric figures, such as squares and angles, use only the parts of lines called segments and rays.

A **segment** is the part of a line consisting of two *endpoints* and all points between them.

A **ray** is the part of a line consisting of one *endpoint* and all the points of the line on one side of the endpoint.



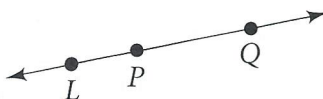
1. Is \overline{AB} the same as \overline{BA} ? Explain.
2. Is \overrightarrow{YX} the same as \overrightarrow{XY} ? Explain.
3. How is a ray like a line? How is a ray different from a line?

A ray in geometry is named after the rays of the sun.

Opposite rays are two collinear rays with the same endpoint. Opposite rays always form a line.

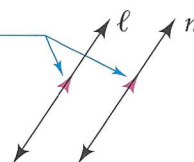


4. a. Name four different rays in the figure below.
- b. Name two opposite rays.



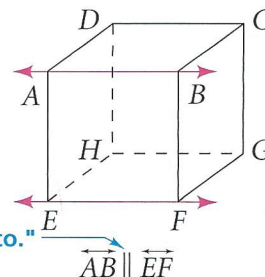
Lines that do not intersect may or may not be coplanar. **Parallel lines** are coplanar lines that do not intersect. Segments and rays are parallel if they lie in parallel lines.

You can use arrowheads to show parallel lines.

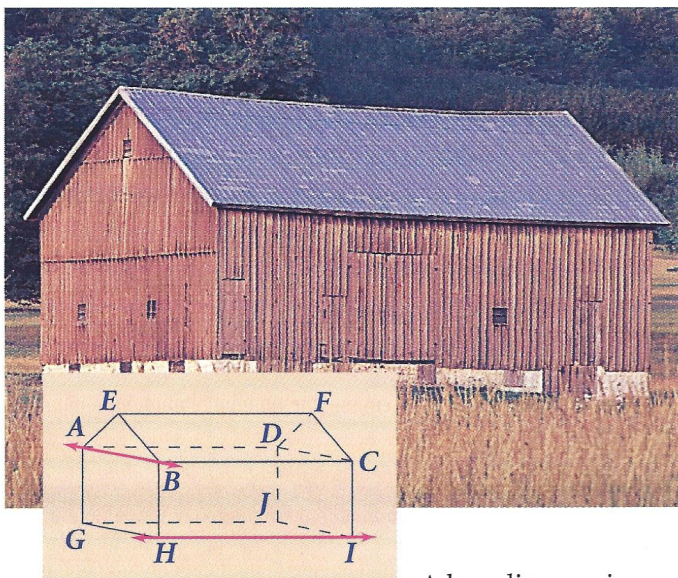


$l \parallel n$

Read "is parallel to."



$\overrightarrow{AB} \parallel \overrightarrow{EF}$



5. Name all the segments shown at the left that are parallel to:

a. \overline{DC}

b. \overline{GJ}

c. \overline{AE}

Skew lines do not lie in the same plane. They are neither parallel nor intersecting.

\overleftrightarrow{AB} and \overleftrightarrow{HI} are skew.

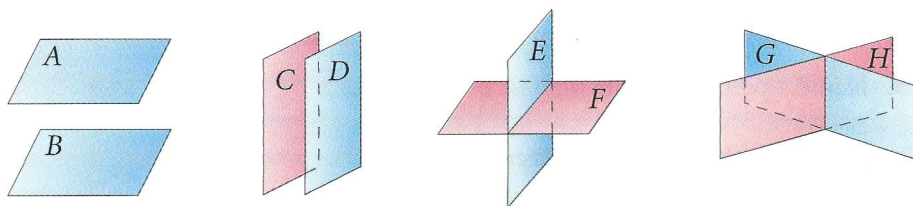
Parallel planes are planes that do not intersect.

plane $ABCD \parallel$ plane $GHIJ$

6. Name some other pairs of skew lines in the diagram at the left.

7. Name two more pairs of parallel planes.

A box diagram is a good way to represent parallel lines and segments, skew lines, and parallel planes. Some other ways to draw planes are shown below.



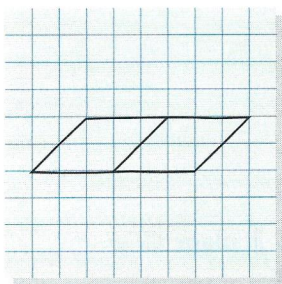
8. Which pairs of planes shown above are parallel? Which are intersecting?

Example

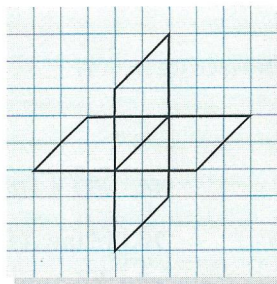
Draw planes A and B intersecting in \overleftrightarrow{FG} .

Using graph paper will help you draw parallel lines and representations of planes.

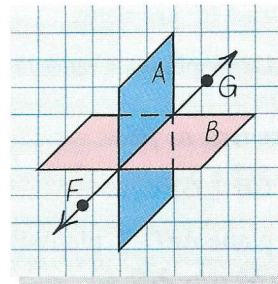
Step 1



Step 2

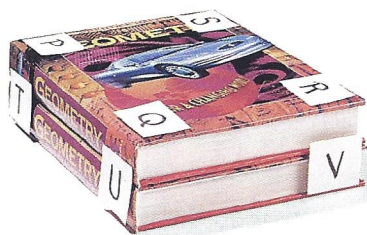


Step 3



9. **Try This** Use graph paper and colored pencils to draw pairs of parallel and intersecting planes like those above Question 8.

WORK TOGETHER



Work in pairs to answer these questions about the lines and planes determined by the surfaces of a rectangular solid.

Stack your geometry books to form a rectangular solid. Label the vertices P, Q, R, S, T, U, V , and W . Identify each of the following.

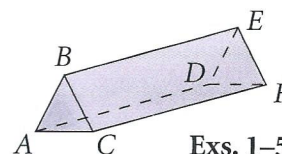
10. three pairs of parallel planes
11. all lines that are parallel to \overleftrightarrow{PQ}
12. all lines that are skew to \overleftrightarrow{PQ}

Exercises ON YOUR OWN

Name all the segments that are parallel to the given segment.

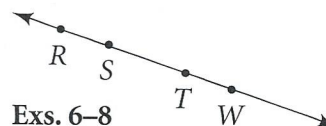
1. \overline{AC}
2. \overline{EF}
3. \overline{AD}

4. Name all the lines that form a pair of skew lines with \overleftrightarrow{AD} .
5. Name a pair of parallel planes.



Use the line at the right for Exercises 6–8.

6. a. Name a pair of opposite rays with point T as endpoint.
b. Name another pair of opposite rays.
7. Name all the segments shown.
8. Name \overrightarrow{RT} two other ways.

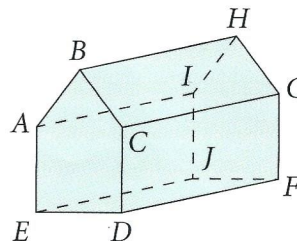


Make a separate sketch for each of the following.

9. Draw three parallel lines a, t , and q .
10. Draw parallel planes A and B .
11. Draw \overleftrightarrow{AB} , \overleftrightarrow{CD} , and \overleftrightarrow{EF} so that $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$, \overleftrightarrow{AB} and \overleftrightarrow{EF} are skew, and \overleftrightarrow{CD} and \overleftrightarrow{EF} are skew.
12. Draw planes C and D , intersecting in \overleftrightarrow{XY} .

Write *true* or *false*.

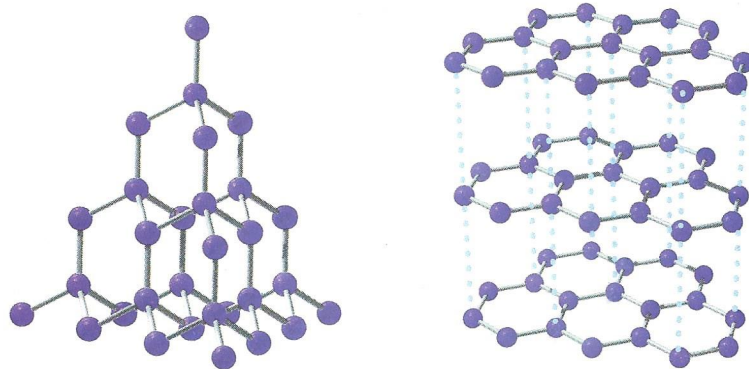
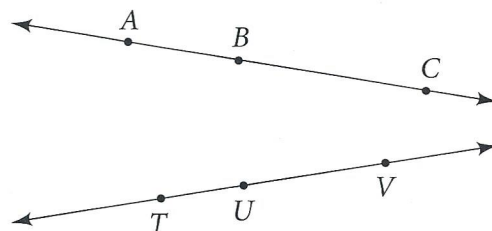
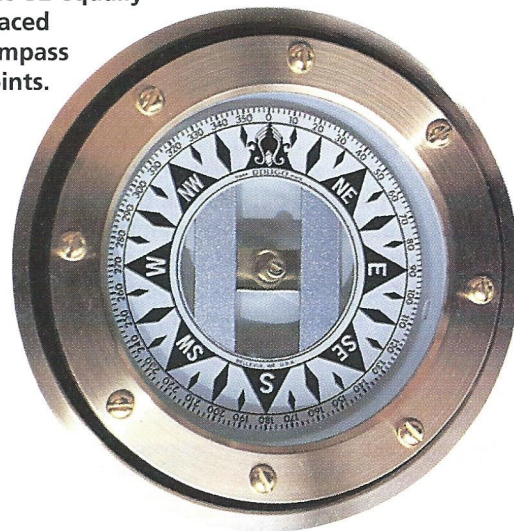
13. $\overleftrightarrow{CB} \parallel \overleftrightarrow{GF}$
14. $\overleftrightarrow{ED} \parallel \overleftrightarrow{HG}$
15. plane $AED \parallel$ plane FGH
16. plane $ABH \parallel$ plane CDF
17. \overleftrightarrow{AB} and \overleftrightarrow{HG} are skew lines.
18. \overleftrightarrow{AE} and \overleftrightarrow{BC} are skew lines.
19. \overleftrightarrow{CF} and \overleftrightarrow{AI} are skew lines.
20. \overleftrightarrow{CF} and \overleftrightarrow{AJ} are skew lines.



Complete with *always*, *sometimes*, or *never* to make a true statement.

21. \overrightarrow{AB} and \overrightarrow{BA} are ? the same ray.
22. \overrightarrow{AB} and \overrightarrow{AC} are ? the same ray.
23. \overline{AX} and \overline{XA} are ? the same segment.
24. \overleftrightarrow{TQ} and \overleftrightarrow{QT} are ? the same line.
25. Two parallel lines are ? coplanar.
26. Skew lines are ? coplanar.
27. Opposite rays ? form a line.
28. Two lines in the same plane are ? parallel.
29. Two planes that do not intersect are ? parallel.
30. Two lines that lie in parallel planes are ? parallel.
31. **Writing** Summarize the different ways that two lines may be related. Give examples from the real world that illustrate the relationships.
32. **Navigation** North and south are directions on a compass that are on opposite rays. Name two other pairs of compass directions that are on opposite rays.
33. **Coordinate Geometry** \overrightarrow{AB} has endpoint $A(2, 3)$ and goes through $B(4, 6)$. Give some possible coordinates for point C so that \overrightarrow{AB} and \overrightarrow{AC} will be opposite rays. Graph your answer.
34. **Inductive Reasoning** Draw a diagram similar to the one shown.
Step 1: Draw \overline{AU} and \overline{BT} . Label their intersection point as X .
Step 2: Draw \overline{AV} and \overline{CT} . Label their intersection point as Y .
Step 3: Draw \overline{BV} and \overline{CU} . Label their intersection point as Z .
 Make a **conjecture** about points X , Y , and Z .
35. **Critical Thinking** Suppose two parallel planes A and B are each intersected by a third plane C . What do you think will be true of the intersection of planes A and C and the intersection of planes B and C ? Give an example in your classroom.
36. **Research** In diamond, each carbon atom bonds to four other carbon atoms in a three-dimensional network. In graphite, each carbon atom bonds to three other carbon atoms in the same plane. The “sheets” or planes of graphite are parallel. Find out how these structures affect the properties of diamond and graphite.

Directions are printed on a compass card, a circle divided into 32 equally-spaced compass points.

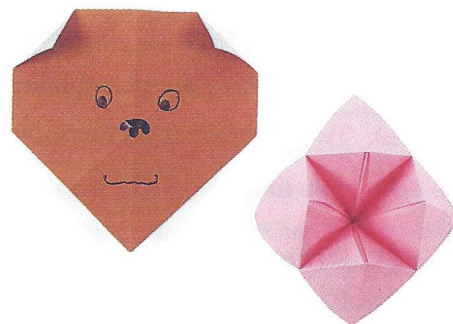


37. **Open-ended** List four pairs of parallel planes in your classroom.
38. **Writing** The term *skew* is from a Middle English word meaning “to escape.” Explain why this might be an appropriate origin for the word that names skew lines.
39. **Standardized Test Prep** Which statement(s) can be true about three planes?
- I. They intersect in a line. II. They intersect in a point. III. They have no points in common.
 A. I only B. II only C. I and II only D. I and III only E. I, II, and III

Chapter Project

Find Out by Creating

Some artists create origami by experimenting. They fold and unfold a piece of paper until they see a resemblance to the real world. Take your folded square from the Find Out question on page 10 (or make a new one). Use the existing creases to construct the dog and the flower pictured at the right. Now try to create your own origami, starting with a fresh square of paper.



Exercises MIXED REVIEW

Find the next two terms in each sequence.

40. 0.1, 0.12, 0.123, 0.1234, ... 41. $-1, -2, -4, -7, -11, -16, \dots$ 42. AB, BC, CD, DE, EF, ...

State the ways you can name each geometric figure.

43. a line 44. a point 45. a plane

46. **Logical Reasoning** Raven made the following **conjecture**: “When you subtract a number from a given number, the answer is always smaller than the given number.” Is her **conjecture** correct? Explain.

Getting Ready for Lesson 1-4

Simplify each expression.

47. $|-6|$ 48. $|3.5|$ 49. $|7 - 10|$
 50. $|-4 - 2|$ 51. $|8 - 5|$ 52. $|4 + 1|$
 53. $|-3 + 12|$ 54. $|-21 + 6|$ 55. $|-11 - (-2)|$

Graph each inequality on a number line.

56. $t > 6$ 57. $9 \leq m$ 58. $w < -4$
 59. $5 > s$ 60. $p \leq 7$ 61. $-1.5 \geq b$
 62. $x \geq -3$ 63. $0 < q$ 64. $-5 \leq v < -2$



FOR YOUR JOURNAL

Choose five geometric terms from this lesson. Describe real-world examples of each.

Solving Linear Equations

Before Lesson 1-4

Sometimes you need to combine like terms when you are solving linear equations.

Example 1

Solve $(5x + 8) - (2x - 9) = 38$.

$$(5x + 8) + (-1)(2x - 9) = 38$$

$$5x + 8 - 2x + 9 = 38$$

$$3x + 17 = 38$$

$$3x = 21$$

$$x = 7$$

$$-(2x - 9) = (-1)(2x - 9)$$

Use the Distributive Property.

Simplify.

Subtract 17 from each side.

Divide each side by 3.

When you are solving equations with variables on both sides, first get all the variables on the same side of the equation.

Example 2

Solve $4x - 9 = 7x - 15$.

$$4x - 9 = 7x - 15$$

$$-9 = 3x - 15$$

$$6 = 3x$$

$$2 = x$$

Subtract 4x from each side.

Add 15 to each side.

Divide each side by 3.

Solve.

1. $5x + 10 - 6x + 3 = 6 - 2x - 2$
2. $(6a - 54) - (5a + 27) = 23$
3. $(2 + 4y) - (y + 9) = 26$
4. $7t - 8t + 4 = 5t - 2$
5. $(9k + 30) - (4k + 10) = 100$
6. $6x + 17 = 9x + 2$
7. $(3x + 10) - 5x = 6x - 50$
8. $(3y - 5) + (5y + 20) = 135$
9. $10n + 12 = 14n - 12$
10. $13c + 40 = 9c - 20 + c$
11. $(4w - 28) + (11w + 13) = 180$
12. $7f + 16 = 3f + 48$
13. $(7a + 3) + (-a - 5) = -16$
14. $3x - 35 = 9x - 59$
15. $7y + 44 = 12y + 11$
16. $(11x - 37) + (5x + 59) = 54$
17. $(7t - 21) + (t + 4) = 15$
18. $(5w + 24) + (2w + 13) = 156$