The legs of the tripod touch the table at three points. The legs suggest lines, and the table surface suggests a plane.

Geometry depends on a common understanding of terms such as point, line, and plane. Because these terms cannot be mathematically defined using other known words, they are called undefined terms.

A point has no dimension. It is represented by a small dot.

A line has one dimension. It extends without end in two directions. It is represented by a line with two arrowheads.

A plane has two dimensions. It is represented by a shape that looks like a floor or wall. You have to imagine that it extends without end.

You need two points to describe a line, and you need three points to describe a plane, because the geometry in this book follows the two postulates given below. Postulates are statements that are accepted without further justification.

### POSTULATES 1 and 2

**Postulate 1 Two Points Determine a Line**

**Words** Through any two points there is exactly one line.

**Symbols** Line $n$ passes through points $P$ and $Q$.

**Postulate 2 Three Points Determine a Plane**

**Words** Through any three points not on a line there is exactly one plane.

**Symbols** Plane $T$ passes through points $A$, $B$, and $C$. 
EXAMPLE 1 Name Points, Lines, and Planes

Use the diagram at the right.

a. Name three points.
b. Name two lines.
c. Name two planes.

Solution

a. $D$, $E$, and $F$ are points.
b. Line $m$ and line $p$
c. $Q$ and $R$ are planes.

Collinear points are points that lie on the same line.

Coplanar points are points that lie on the same plane.

Coplanar lines are lines that lie on the same plane.

EXAMPLE 2 Name Collinear and Coplanar Points

Use the diagram at the right.

a. Name three points that are collinear.
b. Name four points that are coplanar.
c. Name three points that are not collinear.

Solution

a. Points $D$, $E$, and $F$ lie on the same line. So, they are collinear.
b. Points $D$, $E$, $F$, and $G$ lie on the same plane, so they are coplanar.
c. Points $H$, $E$, and $G$ do not lie on the same line. There are many other correct answers.

Visualize It!

In Example 2 the points $D$, $E$, $F$, and $H$ are also coplanar. The plane containing them is shown in green above.

Checkpoint Name Points, Lines, and Planes

Use the diagram at the right.

1. Name two lines.
2. Name two planes.
3. Name three points that are collinear.
4. Name three points that are not collinear.
5. Name four points that are coplanar.
6. Name two lines that are coplanar.
The line $\overrightarrow{AB}$ passes through $A$ and $B$.

The segment $\overline{AB}$ consists of the endpoints $A$ and $B$, and all points on $\overline{AB}$ that are between $A$ and $B$.

The ray $\overrightarrow{AB}$ consists of the endpoint $A$ and all points on $\overrightarrow{AB}$ that lie on the same side of $A$ as $B$.

### Summary: Lines, Segments, and Rays

<table>
<thead>
<tr>
<th>Word</th>
<th>Symbol</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>line</td>
<td>$\overline{AB}$ or $\overline{BA}$</td>
<td>![Diagram of line AB]</td>
</tr>
<tr>
<td>segment</td>
<td>$\overline{AB}$ or $\overline{BA}$</td>
<td>![Diagram of segment AB]</td>
</tr>
<tr>
<td>ray</td>
<td>$\overrightarrow{AB}$</td>
<td>![Diagram of ray AB]</td>
</tr>
</tbody>
</table>

Note that $\overline{AB}$ is the same as $\overline{BA}$. Also, $\overline{AB}$ is the same as $\overline{BA}$. However, $\overrightarrow{AB}$ is not the same as $\overrightarrow{BA}$. The two rays have different endpoints and extend in different directions.

### Example: Draw Lines, Segments, and Rays

Draw three noncollinear points, $J$, $K$, and $L$. Then draw $\overrightarrow{JK}$, $\overrightarrow{KL}$, and $\overrightarrow{LJ}$.

**Solution**

2. **Draw** $\overrightarrow{JK}$.
3. **Draw** $\overrightarrow{KL}$.
4. **Draw** $\overrightarrow{LJ}$.

### Checkpoint: Draw Lines, Segments, and Rays

7. Draw four points as shown.
8. Draw the lines $\overrightarrow{AB}$ and $\overrightarrow{AC}$. Are the lines the same? Explain.
9. Draw the line segments $\overline{AC}$ and $\overline{BD}$. Are the segments the same? Explain.
10. Draw the rays $\overrightarrow{CA}$ and $\overrightarrow{CB}$. Are the rays the same? Explain.
1.3 Points, Lines, and Planes

**Guided Practice**

**Vocabulary Check**

1. Write in words how you would say each of these symbols aloud: \(PQ, PQ, PQ,\) and \(QP\).

2. Explain the difference between \(PQ\) and \(QP\).

**Skill Check**

Decide whether the statement is true or false.

3. Points \(A, B,\) and \(C\) are collinear.

4. Points \(A, B,\) and \(C\) are coplanar.

5. Points \(B, C,\) and \(D\) are coplanar.

6. Point \(C\) lies on \(AB\).

7. \(AB\) lies on plane \(ABC\).

8. \(DE\) lies on plane \(ABC\).

**Practice and Applications**

**Naming Points, Lines, and Planes** Use the diagram at the right.

15. Name four points.

16. Name two lines.

17. Name the plane that contains \(A, B,\) and \(C\).

18. Name the plane that contains \(A, D,\) and \(E\).

**Evaluating Statements** Decide whether the statement is true or false.

19. \(A\) lies on line \(l\).

20. \(A, B,\) and \(C\) are collinear.

21. \(B\) lies on line \(l\).

22. \(A, B,\) and \(C\) are coplanar.

23. \(C\) lies on line \(m\).

24. \(D, E,\) and \(B\) are collinear.

25. \(D\) lies on line \(m\).

26. \(D, E,\) and \(B\) are coplanar.
Naming Collinear Points Name a point that is collinear with the given points.

27. F and H 28. G and K
33. H and G 34. J and F

Naming Noncollinear Points Name three points that are not collinear.

35. 36. 37.

Naming Coplanar Points Name a point that is coplanar with the given points.

40. G, A, and D 41. E, F, and G
42. A, B, and H 43. B, C, and F
44. A, B, and F 45. B, C, and G

Naming Noncoplanar Points Name all the points that are not coplanar with the given points.

46. N, K, and L 47. S, P, and M
50. P, Q, and R 51. R, K, and N

Game Board In Exercises 54–57, use the game board.

54. Name four collinear points.
55. Name three points that are not collinear.
56. Name four segments that contain point R.
57. \( \overline{AD} \) divides the board in half. \( \overline{QT} \) also divides the board in half. Name the other lines that divide the board in half.
In Exercises 58–62, use the diagram of the indoor tennis court.

58. Name two points that are collinear with $P$.

59. Name three points that are coplanar with $P$.

60. Name two planes that contain $J$.

61. Name two planes that do not contain $J$.

62. Are the points $K$ and $N$ coplanar with points $J$ and $Q$? Explain.

### Visualize It!

Sketch the lines, segments, and rays. If you have geometry software, try creating your sketch using it.

63. Draw four points $J$, $K$, $L$, and $M$, no three of which are collinear. Sketch $\overline{JK}$, $\overline{KL}$, $\overline{LM}$, and $\overline{MJ}$.

64. Draw two points, $A$ and $B$. Sketch $\overline{AB}$. Add a point $C$ on the ray so $B$ is between $A$ and $C$.

65. Draw three noncollinear points $F$, $G$, and $H$. Sketch $\overline{FG}$ and add a point $J$ on $\overline{FG}$. Then sketch $\overline{JH}$.

### Three-Wheeled Car

In Exercises 66–69, refer to the photograph of the three-wheeled car.

66. A four-wheeled car is driving slowly over uneven ground. Is it possible that only three wheels will be touching the ground at a given time?

67. Is it possible to draw four points that do not lie on a plane?

68. A three-wheeled car is driving slowly over uneven ground. Is it possible that only two wheels will be touching the ground at a given time?

69. Is it possible to draw three points that do not lie on a plane?
70. **Multiple Choice** Which of the statements is false?

- A. F, G, and H are collinear.
- B. C, D, K, and L are coplanar.
- C. L lies on \( \overrightarrow{AB} \).
- D. \( \overrightarrow{DE} \) contains \( \overrightarrow{CE} \).

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**Mixed Review**

**Describing Number Patterns** Predict the next number. *(Lesson 1.1)*

71. 6, 17, 28, 39, . . .
72. 9, 4, −1, −6, . . .
73. 4, 20, 100, 500, . . .
74. 0, 5, 15, 30, 50, . . .

**Algebra Skills**

**Fractions** Write the fraction as a decimal. For repeating decimals, round to the nearest hundredth. *(Skills Review, p. 657)*

75. \( \frac{1}{2} \)
76. \( \frac{3}{4} \)
77. \( \frac{3}{5} \)
78. \( \frac{4}{10} \)
79. \( \frac{2}{3} \)
80. \( \frac{4}{3} \)
81. \( \frac{7}{9} \)
82. \( \frac{11}{2} \)

---

**Quiz 1**

**Sketch the next figure you expect in the pattern.** *(Lesson 1.1)*

1. [Diagram of three squares]
2. [Diagram of two squares]

**Find a counterexample to prove that the statement is false.** *(Lesson 1.2)*

3. If a number is divisible by 10, then it is divisible by 20.
4. Two sides of a triangle can never have the same length.
5. The sum of two numbers is always greater than either number.
6. If you fold a square piece of paper in half, then unfold it and cut along the fold, you will always create two rectangles of the same size.

**Sketch the figure.** *(Lesson 1.3)*

7. Draw three noncollinear points \( P, Q, \) and \( R \). Sketch \( \overrightarrow{QP} \). Add a point \( T \) on the ray so that \( P \) is between \( Q \) and \( T \). Then sketch \( \overrightarrow{RT} \).
8. Draw four points, \( V, X, Y, \) and \( Z \), no three of which are collinear. Sketch \( \overrightarrow{VY}, \overrightarrow{XZ}, \) and \( \overrightarrow{YZ} \).