1.3 Points, Lines, and Planes

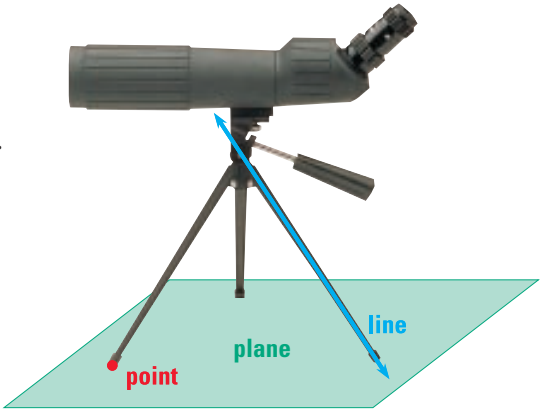
Goal

Use postulates and undefined terms.

Key Words

- undefined term
- point, line, plane
- postulate
- collinear, coplanar
- segment
- ray
- endpoint

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.

point A $\quad\quad$ $\bullet A$

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

line ℓ or $\overleftrightarrow{BC}$ $\quad\quad$ 

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.

plane M or plane DEF $\quad\quad$ 

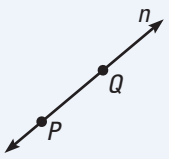
You need two points to describe a line, and you need three points to describe a plane, because the geometry in this book follows the two *postulates* given below. **Postulates** are statements that are accepted without further justification.

POSTULATES 1 and 2

Postulate 1 Two Points Determine a Line

Words Through any two points there is exactly one line.

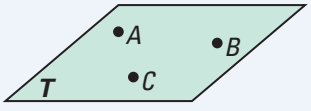
Symbols Line n passes through points P and Q.



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.



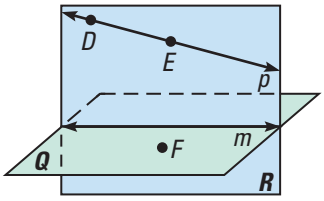
EXAMPLE 1 Name Points, Lines, and Planes

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

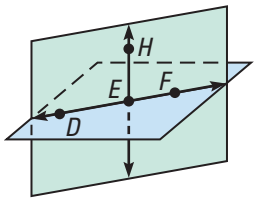
c. Q and R are planes.

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.

Visualize It!



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

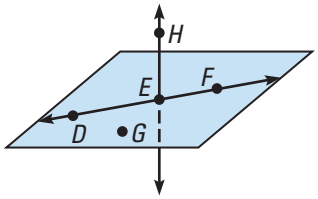
EXAMPLE 2 Name Collinear and Coplanar Points

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.

Checkpoint Name Points, Lines, and Planes

Use the diagram at the right.

1. Name two lines.

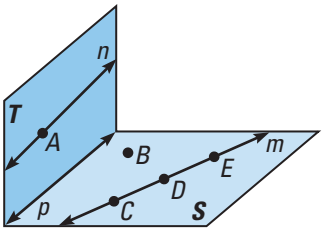
2. Name two planes.

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.



Student Help

VISUAL STRATEGY
Add these words to your vocabulary pages in your notebook, as shown on p. 2.

The line $\overleftrightarrow{AB}$ passes through A and B.

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

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

SUMMARY **LINES, SEGMENTS, and RAYS**

Word	Symbol	Diagram
line	$\overleftrightarrow{AB}$ or $\overleftrightarrow{BA}$	A B
segment	$\overline{AB}$ or $\overline{BA}$	endpoint A B endpoint
ray	$\overrightarrow{AB}$ $\overrightarrow{BA}$	endpoint A B A B endpoint

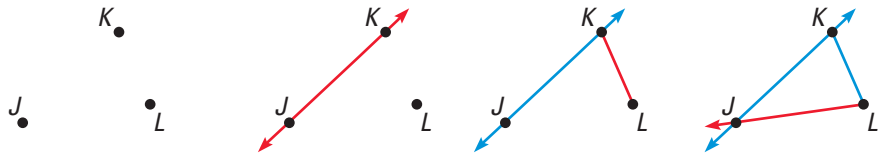
Note that $\overleftrightarrow{AB}$ is the same as $\overleftrightarrow{BA}$. Also, $\overline{AB}$ is the same as $\overline{BA}$. However, $\overrightarrow{AB}$ is not the same as $\overrightarrow{BA}$. The two rays have different endpoints and extend in different directions.

EXAMPLE 3 **Draw Lines, Segments, and Rays**

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

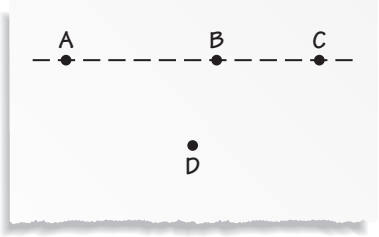
Solution

1 ***Draw*** J, K, and L. **2** ***Draw*** $\overleftrightarrow{JK}$. **3** ***Draw*** $\overline{KL}$. **4** ***Draw*** $\overrightarrow{LJ}$.



Checkpoint **Draw Lines, Segments, and Rays**

7. Draw four points as shown.



8. Draw the lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{AC}$. 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 Exercises

Guided Practice

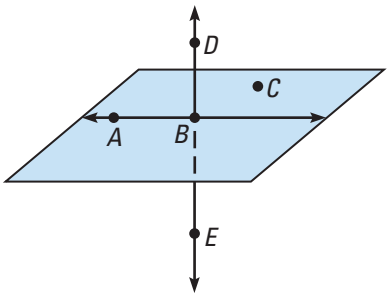
Vocabulary Check

1. Write in words how you would say each of these symbols aloud: $\overleftrightarrow{PQ}$, $\overline{PQ}$, $\overrightarrow{PQ}$, and $\overrightarrow{QP}$.
2. Explain the difference between $\overrightarrow{PQ}$ and $\overrightarrow{QP}$.

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 $\overleftrightarrow{AB}$.
7. $\overleftrightarrow{AB}$ lies on plane ABC.
8. $\overleftrightarrow{DE}$ lies on plane ABC.



Sketch a line that contains point *S* between points *R* and *T*. Decide whether the statement is *true* or *false*.

9. $\overleftrightarrow{RS}$ is the same as $\overleftrightarrow{RT}$.
10. $\overrightarrow{ST}$ is the same as $\overrightarrow{TS}$.
11. $\overrightarrow{ST}$ is the same as $\overrightarrow{RT}$.
12. $\overrightarrow{RS}$ is the same as $\overrightarrow{RT}$.
13. $\overline{RS}$ is the same as $\overline{ST}$.
14. $\overline{ST}$ is the same as $\overline{TS}$.

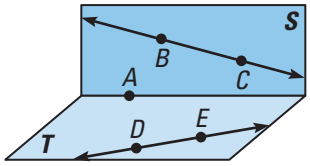
Practice and Applications

Extra Practice

See p. 675.

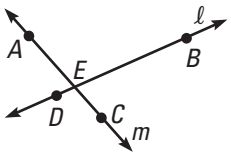
Naming Points, Lines, and Planes **Use the diagram at the right.**

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*.**

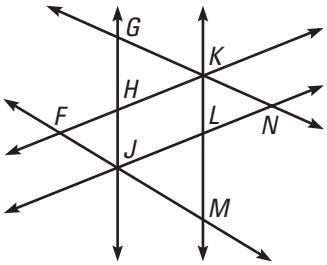
19. A lies on line ℓ.
20. A, B, and C are collinear.
21. B lies on line ℓ.
22. A, B, and C are coplanar.
23. C lies on line m.
24. D, E, and B are collinear.
25. D lies on line m.
26. D, E, and B are coplanar.



Homework Help

Example 1: Exs. 15–18
Example 2: Exs. 19–62
Example 3: Exs. 63–65

Naming Collinear Points **Name a point that is collinear with the given points.**



27. F and H

28. G and K

29. K and L

30. M and J

31. J and N

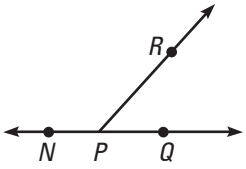
32. K and H

33. H and G

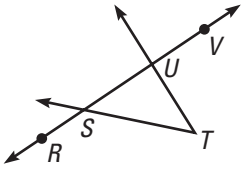
34. J and F

Naming Noncollinear Points **Name three points that are not collinear.**

35.



36.



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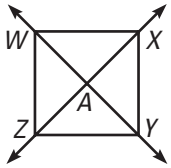


Student Help
CLASSZONE.COM

HOMEWORK HELP
Extra help with problem solving in Exs. 38–53 is at classzone.com

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

38. A, B, and C

39. D, C, and F

40. G, A, and D

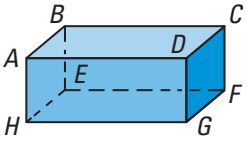
41. E, F, and G

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

48. P, Q, and N

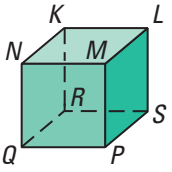
49. R, S, and L

50. P, Q, and R

51. R, K, and N

52. P, S, and K

53. Q, K, and L



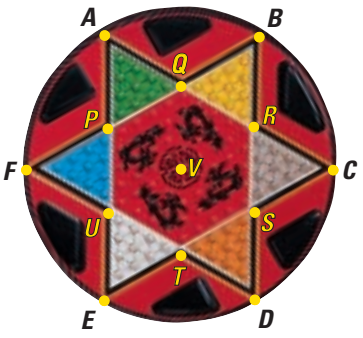
Game Board **In Exercises 54–57, use the game board.**

54. Name four collinear points.

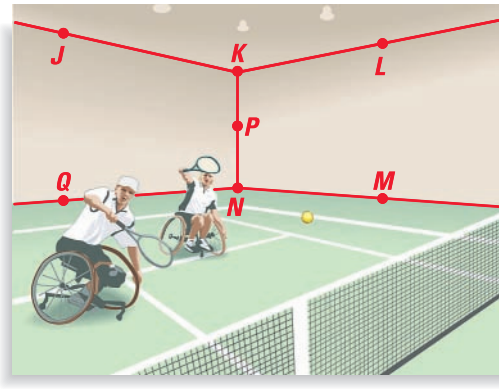
55. Name three points that are not collinear.

56. Name four segments that contain point R.

57. $\overleftrightarrow{AD}$ divides the board in half. $\overleftrightarrow{QT}$ also divides the board in half. Name the other lines that divide the board in half.



You be the Judge **In Exercises 58–62, use the diagram of the indoor tennis court.**



58. Name two points that are collinear with P.

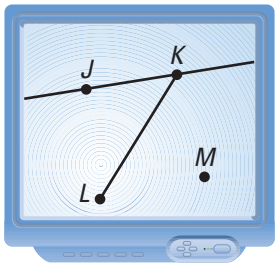
59. Name three points that are coplanar with P.

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 $\overleftrightarrow{JK}$, $\overline{KL}$, $\overleftrightarrow{LM}$, and $\overrightarrow{MJ}$.

64. Draw two points, A and B. Sketch $\overrightarrow{AB}$. 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 $\overrightarrow{JH}$.

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?

Standardized Test Practice

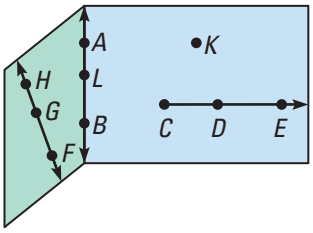
70. Multiple Choice Which of the statements is *false*?

Ⓐ F, G, and H are collinear.

Ⓑ C, D, K, and L are coplanar.

Ⓒ L lies on $\overleftrightarrow{AB}$.

Ⓓ $\overrightarrow{DE}$ contains $\overline{CE}$.



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.** $\frac{4}{10}$

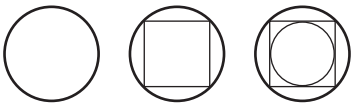
79. $\frac{2}{3}$ **80.** $\frac{4}{3}$ **81.** $\frac{7}{9}$ **82.** $\frac{11}{2}$

Quiz 1

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

1.

2.



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 $\overleftrightarrow{RT}$.

8. Draw four points, V, X, Y, and Z, no three of which are collinear. Sketch $\overleftrightarrow{VY}$, $\overleftrightarrow{XZ}$, and $\overleftrightarrow{YZ}$.