Geometry

Chapter 1: POINTS, LINES, PLANES, AND ANGLES

__________________________
NAME
Section 1-1: A Game and Some Geometry

EQUIDISTANT

Section 1-2: Points, Lines, and Planes

3 Undefined terms in Geometry:

1.

2.

3.

POINT

• A

LINE

A B
COLLINEAR POINTS -

NONCOLLINEAR POINTS -

COPLANAR POINTS -

NONCOPLANAR POINTS -
A LINE CONSISTS OF AT LEAST _____ POINTS.

A PLANE CONSISTS OF AT LEAST _____ POINTS.

SPACE -

INTERSECTION -

The intersection of 2 lines is a ____________.

The intersection of 2 planes is a ____________.

The intersection of a plane and a line not on that plane is a ____________.
Examples:

Classify each statement as true or false.

1. \( \overrightarrow{PF} \) ends at P.
2. Point S is on an infinite number of lines.
3. A plane has no thickness.
4. Collinear points are coplanar.
5. Planes have edges.
6. Two planes intersect in a line segment.
7. Two intersecting lines meet in exactly one point.
8. Points have no size.
9. Line XY can be denoted as \( \overrightarrow{XY} \) or \( \overrightarrow{YX} \).

Use the diagram below to classify each statement as true or false.

10. P is in M.
11. b is in M.
12. \( \overrightarrow{YX} \) contains P.
13. A in on b.
14. A and P are in M.
15. N contains P.
Points, Lines, and Planes

Estimate to compare the values.

1. The distance from \( U \) to \( S \) and the distance from \( U \) to \( T \) ________

2. The area of figure I (area I) and the area of figure II (area II) ________

Classify each statement as true or false. (Write \( T \) or \( F \))

3. \( \vec{AB} \) is in plane \( M \). ________

4. \( M \) contains \( \vec{CD} \). ________

5. \( \vec{AB} \) intersects \( N \) at \( E \). ________

6. \( \vec{AB} \) intersects \( \vec{CD} \) at \( D \). ________

7. \( F \) is in plane \( N \). ________

8. \( B \) is in plane \( N \). ________

9. \( A, D, \) and \( F \) are coplanar. ________

10. \( N \) contains \( C, D, E, \) and \( F \). ________

11. \( E \) is on \( \vec{CD} \). ________

12. \( C, D, \) and \( E \) are collinear. ________

Name a fourth point that is in the same plane as the given points.

13. \( A, B, F \) ________

14. \( E, H, G \) ________

15. \( C, G, E \) ________

16. \( E, B, C \) ________

Name each of the following.

17. Three lines that intersect at point \( E \) ________

18. The plane that does not intersect plane \( FGHE \) ________

19. Two planes that intersect in \( \vec{CG} \) ________

20. Three planes that intersect at point \( D \) ________

Sketch and label the figures described.

21. Vertical planes \( P \) and \( Q \) intersect in \( \vec{RS} \). ________

22. Horizontal plane \( M \) containing \( \vec{AB} \) intersects \( \vec{AC} \) at point \( A \). ________
1–2 Points, Lines, and Planes (continued)

Intersection  the set of points in both figures
(Dashes in the diagrams indicate parts hidden from view.)

Z is on \( \overrightarrow{AB} \).
\( \overrightarrow{AB} \) contains Z.
\( \overrightarrow{AB} \) passes through Z.
\( \overrightarrow{AB} \) and \( \overrightarrow{CD} \) intersect at Z.
Plane M contains \( \overrightarrow{AB} \) and Y.
\( \overrightarrow{CD} \) intersects M at Z.
M and N intersect in \( \overrightarrow{EF} \).
\( \overrightarrow{EF} \) is the intersection of M and N.
M and N contain \( \overrightarrow{EF} \).

Classify each statement as true or false.

1. \( \overrightarrow{BC} \) is in plane M.
2. Plane M contains \( \overrightarrow{AB} \).
3. Line l intersects \( \overrightarrow{AB} \) at point B.
4. \( \overrightarrow{AB} \) and \( \overrightarrow{DA} \) intersect at A.
5. \( \overrightarrow{AD} \) is in plane M.
6. Plane M intersects \( \overrightarrow{AE} \) at point B.
7. \( \overrightarrow{AE} \) intersects plane M at point B.
8. A, B, and E are collinear.
9. B, F, and D are collinear.
10. A, B, and C are coplanar.
12. A, B, C, and G are coplanar.
13. A, B, C, and F are coplanar.

The plane that contains the shaded region can be called plane \( ABCD \).

14. Name three lines that intersect at point G.
15. Name two planes whose intersection is \( \overrightarrow{FB} \).
16. Name the intersection of plane \( EHG \) and plane \( EFBA \).
17. Name two planes that do not intersect.
18. Are points D, H, G, and C coplanar?
19. Are points D, H, G, and F coplanar?
20. Are points A, B, G, and H coplanar?

Sketch and label the figures described. Use dashes for parts hidden from view.

21. Line \( \overrightarrow{AB} \) intersects plane X at point C.
22. Two planes M and N intersect in line l.
23. Horizontal plane \( \overrightarrow{P} \) contains two lines \( \overrightarrow{RS} \) and \( \overrightarrow{TU} \) that intersect at point O.
Section 1-3: Segments, Rays, and Distance

List some pairs of opposite rays.

Opposite Rays - 2 rays that have a

and go in ______________ directions.

List some pairs of opposite rays.
Postulates:

Length of a segment:

Ruler Postulate:

\[ HI = \_
\]

\[ IJ = \_
\]

\[ JK = \_
\]

\[ HJ = \_
\]

\[ IK = \_
\]
Segment Addition Postulate: If B is between A & C, then $AB + BC = \underline{}$.

Example 1  $AC = \underline{}$

$\overline{AB} = 4$  $\overline{BC} = 8$
Example 2  If $AC = 16$, find $x$.

\[\begin{array}{c}
A & \overset{2x}{\rightarrow} & B & \overset{X + 7}{\rightarrow} & C \\
\end{array}\]

Example 3  If $AC = 30$, find $BC$.

\[\begin{array}{c}
A & \overset{3x}{\rightarrow} & B & \overset{4x + 2}{\rightarrow} & C \\
\end{array}\]
Congruent – objects that have the same ________ and __________. 

Congruent Segments – segments that have __________ __________.

If $DE = FG$, then $\overline{DE} \cong \overline{FG}$.

Midpoint of a Segment: the point that ______________ the segment into ____ ____ segments.

\[ X \quad 2 \quad Y \quad 2 \quad Z \]
Example 4

Given $B$ is the midpoint of $\overline{AC}$, $AB = 4x$, and $AC = 32$. Find $x$.

\[ \overline{A} \quad \overline{B} \quad \overline{C} \]

Example 5

Given $B$ is the midpoint of $\overline{AC}$, Find $AC$.

\[ \overline{A} \quad \overline{B} \quad \overline{C} \]

\[ 3x + 2 \quad 4x + 1 \]
Bisector of a Segment: a ______, 
_______________, or  
__________ that intersects a segment at its _______________
1–3 Segments, Rays, and Distance

Objectives: Use symbols for lines, segments, rays, and distances; find distances. Use the Segment Addition Postulate.

In learning a new language, the first things you need to learn are vocabulary and rules of grammar. In geometry, you need vocabulary, symbols, and rules called postulates.

segment A segment is named by giving its endpoints. \(X\) and \(Z\) are the endpoints of \(\overline{XZ}\). \(\overline{XZ}\) and \(\overline{ZX}\) are the same segment. \(Y\) is between \(X\) and \(Z\). \(Y\) must be on \(\overline{XZ}\).

ray A ray is named by giving its endpoint and another point on the ray. The endpoint of a ray is always named first. \(\overrightarrow{XY}\) and \(\overrightarrow{XZ}\) are the same ray. \(\overrightarrow{XZ}\) and \(\overrightarrow{ZX}\) are different rays. \(\overrightarrow{YX}\) and \(\overrightarrow{YZ}\) are opposite rays.

Refer to the diagram at the right.

1. Give several names for the line.
2. Name several segments in the figure.
3. Name several rays in the figure.
4. Name two pairs of opposite rays.

Classify each statement as true or false.

5. \(C\) is between \(A\) and \(B\).
6. \(\overrightarrow{AD}\) and \(\overrightarrow{AG}\) are opposite rays.
7. \(\overrightarrow{CB}\) is the same as \(\overrightarrow{BC}\).
8. \(\overrightarrow{CB}\) is the same as \(\overrightarrow{BC}\).
9. \(\overrightarrow{CB}\) is the same as \(\overrightarrow{BC}\).
10. \(\overrightarrow{CB}\) is the same as \(\overrightarrow{BC}\).
11. \(\overrightarrow{HF}\) is the same as \(\overrightarrow{CB}\).
12. \(\overrightarrow{FA}\) is the same as \(\overrightarrow{BD}\).

length \(XZ\) is the length of \(\overline{XZ}\) or the distance between point \(X\) and point \(Z\).

You can find the length of a segment on the number line by computing the absolute value of the difference of the coordinates of the endpoints. Length must be a positive number.

Example 1

Find \(XZ\) and \(YX\).

\[
\begin{array}{cccccccc}
Y & X & Z \\
-4 & -3 & -2 & -1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\
\end{array}
\]

Solution

\[
XZ = |2 - 5| = |-3| = 3 \quad YX = |-3 - 2| = |-5| = 5
\]

or \(XZ = |5 - 2| = |3| = 3\) \quad or \(YX = 2 - (-3)| = |5| = 5\)

Segment Addition Postulate If \(B\) is between \(A\) and \(C\), then \(AB + BC = AC\).
Example 2

$R$ is between $S$ and $T$, with $RT = x$,
$SR = x + 4$, and $ST = 14$.
Find the value of $x$. Then find $RT$ and $SR$.

Solution

$SR + RT = ST$ (by the Segment Addition Postulate)

$x + x + 4 = 14$
$2x + 4 = 14$
$2x = 10$
$x = 5$
$SR = x + 4 = 5 + 4 = 9$
$RT = x = 5$

**Congruent**

Two objects that have the same size and shape are congruent ($\cong$). For example, congruent segments have the same length. If $AB = CD$, then $AB \cong CD$.

Midpoint of a Segment

A midpoint divides a segment into two congruent segments.
$X$ is the midpoint of $AB$, so $AX \cong XB$.

Bisector of a Segment

A segment bisector is a line, segment, ray, or plane that intersects a segment at its midpoint.
$AX = XB$, so plane $M$, $\overrightarrow{RS}$, and $\overrightarrow{WW}$ are all bisectors of $AB$.

For Exercises 13–16, refer to the number line at the right.

13. Find $BD$.
14. Find the length of $AC$.
15. Find the distance between $B$ and $E$.
16. Find the coordinate of the midpoint of $AE$.

17. Find the value of $x$.

18. In the diagram, $AC \cong CE$ and $B$ is the midpoint of $AC$.

$CD = 2$ and $AB = 3$. Find $BC, AC$, and $DE$. 
I. Vocabulary
- Point
- Line
- Plane
- Space
- Collinear
- Coplaner
- Ray
- Segment
- Distance
- Congruent
- Segment Bisector
- Midpoint of a Segment

II. A is the midpoint of $\overline{DE}$.
Solve for $x$.

$BA = 3x + 6, AC = 18, BC = 5x - 12$

$x = _______
DA = 3x + 60, EA = 10x - 17, x = ______

In the following diagram, C is the midpoint of \( \overline{AE} \).
B is the midpoint of \( \overline{AC} \). CD = 4 and AB = 9.5

AC = ______
DE = ______
Coordinate for D = ______
Coordinate for C = ______
Section 1-4: Angles

Angle - figure formed by 2 rays that have the same endpoint

The rays are the _________.
The common endpoint is the _________.

When naming an angle, use ___ letters, ___ letter, or ___ number.

Name the angle.

Vertex = ______
Sides = ______ and ______

Name 3 angles.

Angles are measured in _________.

There are 4 classifications of angles.

_______

Measures between _____ and _____  Measure ______

_______

Measures between _____ and _____  Measure ______
Protractor Postulate: Given \( \angle QOP \), if \( \overline{OP} \) is paired with \( x \) and \( \overline{OQ} \) is paired with \( y \), then \( m\angle QOP = |x - y| \).

Example 1  
20° and 90°

Example 2  
90° and 120°

Example 3  
90° and 40°

Angle Addition Postulate: If point B lies in the interior of \( \angle AOC \), then \( m\angle AOB + m\angle BOC = m\angle AOC \).

\[ \begin{array}{c}
\text{A} \\
\text{O} \\
\text{B} \\
\text{C}
\end{array} \]

Angle Addition Postulate: If \( \angle AOC \) is a straight angle, then \( m\angle AOB + m\angle BOC = 180° \).

\[ \begin{array}{c}
\text{A} \\
\text{O} \\
\text{B} \\
\text{C}
\end{array} \]
congruent angles - angles that have

adjacent angles - 2 angles in a ___________ that have a ___________

            ___________ and a ___________ ___________, but

no common interior points

bisector of an angle - a _____ that divides an angle into 2

            ________________ angles

Ex. Given: \( \overline{EC} \) bisects \( \angle BED \), \( m\angle AEB = 19x \), \( m\angle BEC = 8x + 20 \)
Find: \( x \) & \( m\angle CED \)
Examples:

Give another name for each angle.

1. $\angle$ DEB
2. $\angle$ CBE
3. $\angle$ BEA
4. $\angle$ DAB
5. $\angle$ 7
6. $\angle$ 9
7. $m \angle 1 + m \angle 2 = m \angle ______$
8. $m \angle 3 + m \angle 4 = m \angle ______$
9. $m \angle 5 + m \angle 6 = m \angle ______$ or ______

10. Name the vertex of $\angle$ 3.

11. Name the right angle.

State another name for each angle.

12. $\angle$ 1
13. $\angle$ 6
14. $\angle$ EBD
15. $\angle$ 4
16. $\angle$ BDE or $\angle$ BDA
17. $\angle$ 2
18. $\angle$ 5
19. $\angle$ 9
1–4 Angles

Objectives: Name angles and find their measures. Use the Angle Addition Postulate.

angle A figure formed by two rays with the same endpoint is an angle.
In \( \angle XYZ \), \( \overline{XY} \) and \( \overline{YZ} \) are the sides of the angle. \( Y \) is called the
vertex of the angle. Another name for \( \angle XYZ \) is \( \angle Y \).

Example 1

a. Name three different angles in the diagram.
b. Give another name for \( \angle PQR \) and for \( \angle 3 \).

Solution

a. \( \angle PQS, \angle PQR, \angle RQS \)
b. \( \angle PQR \) can be called \( \angle 2; \angle 3 \) can be called \( \angle RQS \).
In this figure, you could not call any of the angles \( \angle Q \)
because it would not be clear which angle with vertex \( Q \) you meant.

Refer to the diagram at the right.

1. Name the vertex and sides of \( \angle XAC \).
2. How many angles have \( A \) as the vertex?
   List them.
3. Give another name for \( \angle 6, \angle ABC, \angle ADC \), and \( \angle 4 \).

measure of an angle You can use a protractor to find a number associated with each side
of an angle. To find the measure in degrees of an angle \( (m \angle XYZ) \),
compute the absolute value of the difference of these numbers.

Example 2

Find \( m \angle COD \) and \( m \angle BOE \).

Solution

As you can see, \( \overrightarrow{OD} \) is on 60 and \( \overrightarrow{OC} \) is on 145.
\[
m \angle COD = |60 - 145|
\]
\[
= | -85 |
\]
\[
= 85
\]
\[
m \angle BOE = |25 - 0|
\]
\[
= 25
\]

Referring to the protractor and angles in Example 2 above:
\( \angle XOC \) is \textbf{acute} since \( 0 < m \angle XOC < 90 \).
\( \angle AOE \) is an \textbf{obtuse} since \( 90 < m \angle AOE < 180 \).
\( \angle AOX \) is a \textbf{right} angle since \( m \angle AOX = 90 \).
\( \angle AOB \) is a \textbf{straight} angle since \( m \angle AOB = 180 \).
1–4 Angles (continued)

State whether each angle appears to be acute, right, obtuse, or straight. Then estimate its measure.

4. $\angle Q$
5. $\angle 1$
6. $\angle RPM$
7. $\angle LMN$
8. $\angle PMQ$
9. $\angle PML$

**Angle Addition Postulate**

If a point $Y$ lies in the interior of $\angle XOZ$, then

$m \angle XOY + m \angle YOZ = m \angle XOZ$.

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**Example 3**

Given: $m \angle AOD = 4y - 8; m \angle DOC = y - 11; m \angle COB = y + 13$

Find the measure of $\angle AOD$.

**Solution**

$m \angle AOD + m \angle DOC + m \angle COB = 180$ (by the Angle Addition Postulate)

$4y - 8 + y - 11 + y + 13 = 180$

$6y - 6 = 180$

$6y = 186$

$y = 31$

$m \angle AOD = 4y - 8 = 4(31) - 8 = 116$

---

**congruent angles**

Two angles with equal measures are congruent.

If $m \angle 5 = m \angle 6$, then $\angle 5 \equiv \angle 6$.

**bisector of an angle**

The ray that divides an angle into two congruent angles is the angle bisector.

If $\overline{QR}$ bisects $\angle PQS$, then $\angle 5 \equiv \angle 6$,

or $m \angle 5 = m \angle 6$.

**adjacent angles**

Coplanar angles with a common vertex and a common side but no common interior points are adjacent angles.

$\angle 1$ is adjacent to $\angle 2$.

---

**Complete.**

10. $\angle 2$ and $\angle 3$ are adjacent. Name their common vertex and common side.

11. $\angle 1$ is adjacent to acute $\angle _____$.

12. $m \angle DZE = _____, m \angle CZD = _____, m \angle AZC = _____$

13. If $\overline{ZB}$ bisects $\angle AZC$, then $m \angle _____ = m \angle _____ = _____$.

14. $m \angle 1 + m \angle 2 + m \angle 3 = _____$

15. If $m \angle 3 = 20, m \angle 2 = 3x - 5$, and $m \angle 1 = 2x + 10$,

find the value of $x$. 

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Practice 2
Supplementary Practice

In Exercises 1–8, \(L\) is the midpoint of \(\overline{KM}\).

1. The ray opposite to \(\overrightarrow{KN}\) is \(\underline{\hspace{2cm}}\).
2. Another name for \(\overline{LM}\) is \(\underline{\hspace{2cm}}\).
3. The coordinate of \(L\) is \(\underline{\hspace{2cm}}\).
4. The length of \(\overline{LN}\) is \(\underline{\hspace{2cm}}\).
5. \(M\) = \(\underline{\hspace{2cm}}\)
6. A segment congruent to \(\overline{KM}\) is \(\underline{\hspace{2cm}}\).
7. The point on \(\overline{LM}\) whose distance from \(L\) is 2 is \(\underline{\hspace{2cm}}\).
8. The point on \(\overline{LK}\) whose distance from \(L\) is 2 is \(\underline{\hspace{2cm}}\).

In Exercises 9–12, refer to the diagram and classify each angle as acute, right, obtuse, or straight.

9. \(\angle A\) = \(\underline{\hspace{2cm}}\)
10. \(\angle ABC\) = \(\underline{\hspace{2cm}}\)
11. \(\angle BDC\) = \(\underline{\hspace{2cm}}\)
12. \(\angle ADC\) = \(\underline{\hspace{2cm}}\)

13. An angle adjacent to \(\angle ADB\) is \(\underline{\hspace{2cm}}\).
14. Can you conclude from the diagram that \(A, B,\) and \(E\) are collinear? \(\underline{\hspace{2cm}}\)
15. Can you conclude from the diagram that \(\overline{BE} \cong \overline{BD}\)? \(\underline{\hspace{2cm}}\)
16. Name the postulate that allows you to conclude that \(m\angle ABD + m\angle DBC = m\angle ABC\). \(\underline{\hspace{2cm}}\)

17. \(\overline{CB}\) is a side of angle \(\underline{\hspace{2cm}}\).
18. \(m\angle CBE\) = \(\underline{\hspace{2cm}}\)
19. \(m\angle ADB\) = \(\underline{\hspace{2cm}}\)

In Exercises 20 and 21, \(\angle POS\) is a right angle and \(\overline{OR}\) bisects \(\angle QOS\). Find the value of \(x\).

20. If \(m\angle 1 = 2x + 15\) and \(m\angle 2 = 5x - 18\), then \(x = \underline{\hspace{2cm}}\).
21. If \(m\angle 1 = x + 7\) and \(m\angle 3 = 2x\), then \(x = \underline{\hspace{2cm}}\).
Segments and Distance; Angles

The numbers given are the coordinates of two points on a number line. State the distance between the points.

1. \(-3\) and \(5\) 
2. \(-15\) and \(-8\) 
3. \(-1\) and \(9\) 
4. \(-11\) and \(-27\)

Name each of the following.

5. The point on \(GC\) whose distance from \(G\) is 3
6. Two points whose distance from \(I\) is 4

7. The midpoint of \(D\bar{J}\)
8. The coordinate of the midpoint of \(C\bar{G}\)
9. The ray opposite to \(D\bar{F}\)
10. A segment congruent to \(D\bar{L}\)

\(R\) is the midpoint of \(PS\). Find the value of \(x\).

11. \(PR = 3x + 2, RS = 5x - 4\)
12. \(PR = 6x - 1, PS = 8x\)

Name each of the following.

13. The vertex of \(\angle 1\)
14. The sides of \(\angle 5\)

State another name for the given angle.

15. \(\angle 7\)
16. \(\angle CBE\)

State whether the angle appears to be acute, right, obtuse, or straight.

17. \(\angle 2\)
18. \(\angle DEC\)
19. \(\angle AEC\)
20. \(\angle CBA\)

Complete.

21. \(\angle DEC\) and ___________ are adjacent angles.

22. \(m\angle 1 + m\angle 2 = m\angle \) ___________

23. If \(m\angle 5 = 3x - 6\), and \(m\angle 6 = 4x + 4\), then \(x = \) __________.

Tell whether you can reach the conclusion shown based on the diagram. Write Yes or No.

24. \(\overrightarrow{DB}\) bisects \(\overrightarrow{AC}\).
25. \(m\angle DAB = 90\)

26. \(E\) is on \(\overrightarrow{AC}\).
27. \(\overrightarrow{AC}\) bisects \(\angle DAB\).
Section 1-5: Postulates and Theorems Relating Points, Lines, and Planes

Recall that we have accepted, without proof, the following four basic assumptions.

_____________________
_____________________
_____________________
_____________________

These postulates deal with segments, lengths, angles, and measures. The following five basic assumptions deal with the way points, lines, and planes are related.

Postulate 5
A line contains at least _________ points; a plane contains at least _________ points not all in one line; space contains at least _________ points not all in one plane.

Postulate 6
Through any two points there is exactly _________ line.

Postulate 7
Through any three points there is at least _________ plane, and through any three noncollinear points there is exactly _________ plane.

Postulate 8
If two points are in a plane, then the _________ that contains the points is in that plane.

Postulate 9
If two planes intersect, then their intersection is a ____________.

Important statements that are ___________ are called ________________. In classroom Exercise 1 you will see how Theorem 1-1 follows from postulates. In Written Exercise 20 you will complete an argument that justifies Theorem 1-2. You will learn about writing proofs in the next chapter.

Theorem 1-1
If two lines intersect, then they intersect in exactly ______ point.

Theorem 1-2
Through a line and a point not in the line there is exactly one __________.

Theorem 1-3
If two lines intersect, then exactly one _________ contains the lines.

The phrase “exactly one” appears several times in the postulates and theorems of this section. The phrase “one and only one” has the same meaning. For example, here is another correct form of Theorem 1-1;

If two lines intersect, then they intersect in one and only one _________.

The theorem states that a point of intersection _________ (there is at least one point of intersection) and the point of intersection is _________ (no more than one such point exists).
Examples:

Classify each statement as true or false.

1. A postulate is a statement assumed to be true without proof.

2. The phrase “exactly one” has the same meaning as the phrase “one and only one.”

3. Three points determine a plane.

4. Through any two points there is exactly one plane.

5. Through a line and a point not on the line there is one and only one plane.
Postulates and Theorems Relating Points, Lines, and Planes

Classify each statement as true or false.
1. Two points can lie in each of two different lines. ________
2. Three noncollinear points can lie in each of two different planes. ________
3. Three collinear points lie in only one plane. ________
4. Two intersecting lines are contained in exactly one plane. ________
5. If two lines intersect, then they intersect in exactly one point. ________
6. If two planes intersect, then their intersection is a line. ________

Name each of the following.
7. The plane that contains $\overrightarrow{BF}$ and $\overrightarrow{FG}$ ________
8. The plane that contains points $B$, $F$, and $H$ ________
9. The plane that intersects $ADHE$ in $\overrightarrow{AE}$ ________
10. The plane that doesn't intersect $ABCD$ ________
11. The intersection of planes $ADHE$, $DCGH$, and $ABCD$ ________
12. The plane that doesn't contain $\overrightarrow{DG}$ and doesn't intersect $\overrightarrow{DG}$ ________
13. Two lines that don't intersect plane $EFGH$ ________
14. Three planes that don't intersect $\overrightarrow{CG}$ and don't contain $\overrightarrow{CG}$ ________

Write the postulate or theorem that justifies the statement about the diagram.
15. Plane $BCGF$ is the only plane containing $\overrightarrow{FG}$ and point $C$. ________
16. Lines $\overrightarrow{BF}$ and $\overrightarrow{FG}$ intersect in only one point. ________
17. $\overrightarrow{FH}$ is contained in the plane $FGHE$. ________
18. Planes $ADHE$ and $EFGH$ intersect in only one line. ________
1–5 Postulates and Theorems
Relating Points, Lines, and Planes \((\text{continued})\)

Draw a figure to represent each of the following:

1. Three coplanar lines that do not intersect
2. Three coplanar lines that intersect in exactly one point
3. A line that intersects each of two coplanar non-intersecting lines
4. Three planes that do not intersect
5. Three planes that intersect in one line
6. A plane that intersects two non-intersecting planes
7. Three planes that intersect in exactly one point

In Exercises 8–15 you will have to visualize certain lines and planes not shown in the diagram. When you name a plane, name it by using four points, no three of which are collinear. Often, more than one answer is possible.

8. Name a plane that contains \(\overrightarrow{PR}\).
9. Name a plane that contains \(\overrightarrow{PR}\) but is not shown in the diagram.
10. Name a plane that contains \(\overrightarrow{PQ}\) and \(\overrightarrow{WK}\).
11. Name a plane that contains \(\overrightarrow{TW}\) and \(\overrightarrow{QR}\).
12. Name the intersection of plane \(TWRQ\) and plane \(PSWT\).
13. Name five lines in the diagram that don’t intersect plane \(UVRQ\).
14. Name one line that is not shown in the diagram that does not intersect plane \(UVRQ\).
15. Name three planes that don’t intersect \(\overrightarrow{SR}\) and don’t contain \(\overrightarrow{SR}\).

Classify each statement as true or false.

16. The intersection of a line and a plane may be the line itself.
18. Two points can determine two lines.
20. Postulates are statements to be proved.
22. A line and a point not on it determine one plane.
24. Line \(l\) always has at least two points on it.
26. Any three points are always coplanar.
28. Two intersecting lines determine a plane.
30. If points \(A, B, C,\) and \(D\) are noncoplanar, then no one plane contains all four of them.
32. Three planes can intersect in exactly one point.

17. Three noncollinear points determine exactly one line.
19. Two lines can intersect in exactly one point.
21. Two points determine a plane.
23. A plane contains at least three noncollinear points.
25. Theorems are statements to be proved.
27. It is possible that points \(P\) and \(Q\) are in plane \(M\) but \(\overrightarrow{PQ}\) is not.
29. Two planes can intersect in two lines.
31. Two planes can intersect in exactly one point.
33. A line and a plane can intersect in exactly one point.
Practice 3
Definitions and Postulates

Refer to the diagram and name each of the following.

1. An angle adjacent to \( \angle PQT \) __________
2. The ray opposite to \( \overrightarrow{TS} \) __________
3. An obtuse angle __________
4. The sides of \( \angle TQR \) __________ and __________
5. Two right angles __________ and __________
6. A point on \( \overrightarrow{PQ} \) that is not on \( \overrightarrow{PQ} \) __________
7. The vertex of the 20° angle __________
8. The point between \( P \) and \( R \) __________

Classify each statement as true or false.

9. Through any two points there is exactly one line. __________
10. Through any three points there is exactly one line. __________
11. Through any three points there is exactly one plane. __________
12. Two lines intersect in exactly one point. __________
13. Two planes intersect in exactly one point. __________
14. Two planes intersect in a line. __________
15. A line and a plane can intersect in a point. __________

Complete each statement with the word always, sometimes, or never.

16. Adjacent angles are __________ congruent.
17. If points \( A \) and \( B \) are in plane \( R \) and point \( C \) is on \( \overrightarrow{AB} \), then \( C \) is __________ in \( R \).
18. Two intersecting lines __________ lie in exactly one plane.
19. A line and a point not on the line __________ lie in more than one plane.
20. A line __________ contains at least two points.
Practice 4
Chapter 1 Practice

In Exercises 1–3, answer on the basis of what appears to be true.

1. Describe the points that are equidistant from $X$ and $Y$.

2. Describe the points that are 1 cm from $Z$.

3. How many points are 1 cm from $Z$ and equidistant from $X$ and $Y$?

Refer to the diagram at the right.

4. Name an obtuse angle.

5. Name a straight angle.

6. Name two lines that intersect at $X$.

7. Name the ray opposite to $BA$.

8. Name the sides of $\angle 2$.

9. Name three noncollinear points.

10. How many planes contain $AB$ and $BD$?

11. How many planes contain points $A$, $B$, and $C$?

12. How many planes contain points $A$, $B$, and $D$?

13. If $m\angle 2 = 50$, then $m\angle FBC = \ldots$ and $m\angle 1 = \ldots$.

14. Can you conclude from the figure that $\angle 1 \cong \angle 2$?

15. Name the postulate that allows you to conclude that $CX + XD = CD$.

16. If $BX$ bisects $\angle DBC$, then $\ldots \equiv \ldots$.

17. $x$ is the number paired with the bisector of $\angle LMN$.

18. Find the value of $y$.

19. $M$ is the midpoint of $\overline{AB}$.

The coordinate of $A$ is $\ldots$.
Points, Lines, Planes, and Angles

Complete.
1. \( \stackrel{ightarrow}{GH} \) intersects plane \( R \) at point _______.
2. \( D, E, \) and _____ are collinear.
3. \( m\angle AEC + m\angle CEB = \) ________________.
4. If \( E \) is the midpoint of \( AB, AE = 2l, \) and \( EB = 2x - 3, \) then
   the value of \( x \) is ________.

5. What is the coordinate of \( K? \) ________
6. What is the point with coordinate \(-2?\) ________
7. What is the distance \( JM? \) ________
8. Which ray is opposite to \( \overrightarrow{LM}? \) ________
9. State another name for \( \angle 1. \) ________
10. \( m\angle AHE + m\angle EHC = \) ____________
11. State whether \( \angle CHG \) appears to be acute, right, obtuse, or straight. ________

Write the name of the definition or postulate that justifies the statement about the diagram.

12. \( m\angle 1 + m\angle 2 = m\angle AHF \) ____________________
13. If \( H \) is the midpoint of \( \overline{CD}, \) then \( DH = CH. \) ____________________
14. If \( \overrightarrow{HC} \) bisects \( \angle BHF, \) then \( \angle 3 \cong \angle 4. \) ____________________
15. \( CH + HD = CD \) ____________________

Name each of the following.
16. The sides of \( \angle EHB \) ________
17. A right angle ________
18. An angle bisector ________
19. Two congruent adjacent angles ________

Classify each statement as true or false.
20. Two planes intersect in exactly one point. ________
21. Two intersecting lines are always coplanar. ________
22. Three collinear points lie in exactly one plane. ________
23. There is exactly one line through two points. ________
Review for Chapter 1 Test

1. Name a plane that contains $HF$.
2. Name the intersection of planes R and Y.
3. How many lines can contain points X and F?
4. How many planes can contain points B, E, and X?
5. How many planes can contain points B and E?

Complete each statement with a number and/or the words line, point, or plane.

6. If $h$ is a line and P is a point not on the line, then $h$ and P are contained in exactly ______ _________.

7. If two lines intersect, then their intersection is a _________.

8. Space contains at least ______ noncoplanar points.

9. Any line contains at least ______ points.

10. If two planes intersect, then their intersection is a _________.

11. Given any three noncollinear points, there is exactly ______ _______ containing them.

12. Given any two points, there is exactly ______ _______ containing the two points.
A is the midpoint of $\overline{DJ}$ and $\angle LAM \cong \angle MAJ$.

13. Name two congruent segments.

14. Name a ray opposite to $\overrightarrow{AJ}$.

15. $UA + AL = \underline{\text{_____}}$. (letters)

16. The sides of $\angle DAU$ are $\underline{\text{_____}}$.

17. A is the $\underline{\text{_____}}$ of $\angle DAU$.

18. Name an angle bisector.

19. If $m \angle UAD = 60$, then $m \angle DAL = \underline{\text{_____}}$.

20. $m \angle DAL + m \angle LAM = m \angle \underline{\text{_____}}$.

21. What type of angle is $\angle DAL$?

22. If $m \angle LAJ = 50$, then $m \angle MAJ = \underline{\text{_____}}$.

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V is the midpoint of $\overline{SR}$ and $SU = 2$.

23. $VR = \underline{\text{_____}}$.

24. $UV = \underline{\text{_____}}$.

25. Find the coordinate of the midpoint of $\overline{SV}$.

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26. K is the midpoint of $\overline{PQ}$. If $PK = 5x + 9$, $KQ = 8x - 6$, then $x = \underline{\text{_____}}$.

27. If $m \angle 3 = 8x + 7$ and $m \angle 4 = 2x + 13$, then $x = \underline{\text{_____}}$. 
Fill in the Blank

28. ________ are points all in one plane.

29. ________: If B is between A and C, then AB + BC = AC. (True or False)

30. A ________ angle is an angle that measures exactly 90 degrees.

31. ________ are two angles in the same plane that have a common vertex and a common side but no common interior points.