

Math

Common Core State Standards

High School Geometry

Coordinate Geometry, Triangles, Parallelograms, Similarity, Three-Dimensional Figures, Probability, and more!

BUILDING BLOCKS OF GEOMETRY G.CO.1

Points, Lines, & Planes

A **point** is an exact location. It has no size or shape. Points are typically labeled with capital letters.

EX: point *G* and point *F*



A **line** is made up of an infinite number of points. It has infinite length and no width. There is exactly one line through any two points. Lines are typically named by a lowercase script letter or by two points on the line.

EX: line *l*, \overleftrightarrow{CD} , \overleftrightarrow{DC} , line \overleftrightarrow{CD} , line \overleftrightarrow{DC}



A **plane** is a flat surface made up of an infinite number of points. It has no thickness and extends infinitely in all directions. There is exactly one plane through any three points. Planes are typically named by a capital script letter or by three points on the plane that do not lie in the same line.

EX: plane *P*, plane \overleftrightarrow{RST} , plane \overleftrightarrow{SRT} , plane \overleftrightarrow{STR} , plane \overleftrightarrow{TSR} , plane \overleftrightarrow{TRS}



Collinear points lie on the same line, while **noncollinear points** do not. **Coplanar points** lie in the same plane, while **noncoplanar points** do not.

Distance & Midpoints

A **line segment** is a section of a line that starts at one point and ends at another point.

These points are the **endpoints** of the line segment. Because a line segment has a starting point and an ending point, it has finite length that can be measured.

EX: segment \overline{XY} , segment \overline{YX} , \overline{XY} , \overline{YX} has length 5.2 cm

The **midpoint** of a segment is the point that lies halfway between the endpoints. A **segment bisector** is a segment, line, or plane that intersects a segment at its midpoint.



Angles

A **ray** is part of a line. Rays have one endpoint and extend infinitely in one direction. Two rays that share a common endpoint and are noncollinear form an **angle**. The rays are the **sides** of the angle, and the common endpoint is called the **vertex** of the angle. Angles are typically named by using the vertex, and a point on each side of the angle, or by using a number.

EX: $\angle A$, $\angle M$, $\angle AMN$, $\angle NMA$ is formed by rays \overrightarrow{MA} and \overrightarrow{MN} (the sides of the angle) and has vertex *M*.



Angles are measured in **degrees**, which are labeled with the symbol $^\circ$. There are 360° in one full rotation around a circle.



Parallel & Perpendicular Lines

Lines, segments, or rays that form a right angle are called **perpendicular** and are represented by the symbol \perp .

EX: line *a* \perp line *b*



Parallel lines are coplanar lines that never intersect.

Parallel lines are represented by the symbol \parallel .

EX: line *c* \parallel line *d*



COORDINATE GEOMETRY G.GPE.4, G.GPE.5, G.GPE.7

The coordinate plane can be used to demonstrate and verify many geometric properties.

Slopes of Parallel & Perpendicular Lines

The **slope** of a line or segment is the ratio of the vertical rise to the horizontal run. For two points on the line or segment, the slope can be calculated as the change in the *y*-coordinates divided by the change in the *x*-coordinates.

Slope Formula: For the points (x_1, y_1) and (x_2, y_2) , the slope of the line or segment that connects the points is given by $m = \frac{y_2 - y_1}{x_2 - x_1}$.

Parallel lines have the same slope, and perpendicular lines have slopes that are opposite reciprocals.

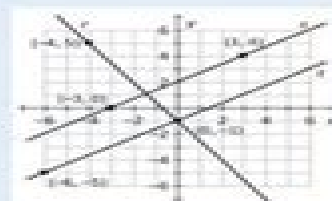
EX: Find the slope of each line and determine the relationships between them.

$$\text{slope of line } r: \frac{-1-5}{0-(-4)} = \frac{-6}{-4} = \frac{3}{2}$$

$$\text{slope of line } s: \frac{4-0}{3-(-3)} = \frac{4}{6} = \frac{2}{3}$$

$$\text{slope of line } t: \frac{-1-(-5)}{0-(-6)} = \frac{4}{6} = \frac{2}{3}$$

Lines *s* and *t* have the same slope, so they are parallel. The slope of line *r* is the opposite reciprocal of the slope of lines *s* and *t*. So, line *r* is perpendicular to both line *s* and line *t*.



Distance Formula

Length can be calculated on the coordinate plane using the **Distance Formula**. The distance between two points on the coordinate plane is given by the formula

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

EX: Find the length of \overline{RS} with endpoints $R(3, -5)$ and $S(-2, 6)$.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad \text{Distance Formula}$$

$$d = \sqrt{(-2-3)^2 + (6-(-5))^2} \quad \text{Substitute the coordinates of the endpoints.}$$

$$d = \sqrt{145} \quad \text{Simplify.}$$

The length of \overline{RS} is $\sqrt{145} \approx 12.1$ units.

Figures on the Coordinate Plane

Geometric figures can be represented on the coordinate plane, and you can use slopes and the Distance Formula to analyze them.

EX: Quadrilateral $ABCD$ has vertices located at $A(-6, 2)$, $B(4, 4)$, $C(5, -1)$, and $D(-5, -3)$. Determine the type of quadrilateral and find the area.

1. Plot the figure on a coordinate plane.

Then find the slopes of the sides.

$$\text{slope of } \overline{AB}: \frac{1}{5}$$

$$\text{slope of } \overline{BC}: -5$$

$$\text{slope of } \overline{CD}: \frac{1}{5}$$

$$\text{slope of } \overline{AD}: -5$$

2. Find the lengths of the sides.

$$\overline{AB} = \sqrt{104} = 2\sqrt{26}$$

$$\overline{BC} = \sqrt{26}$$

$$\overline{CD} = \sqrt{104} = 2\sqrt{26}$$

$$\overline{AD} = \sqrt{26}$$

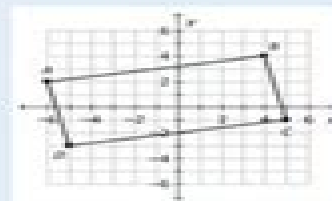
3. Classify the quadrilateral.

$ABCD$ has sides that are perpendicular, so they form 90° angles.

The opposite sides of $ABCD$ are congruent. The quadrilateral is a rectangle.

4. Find the area of $ABCD$.

$$\text{area} = 2\sqrt{26}(\sqrt{26}) = 2(26) = 52 \text{ square units}$$



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1. Understanding the eBook Geometry 10 Grade Book
 - The Rise of Digital Reading Geometry 10 Grade Book
 - Advantages of eBooks Over Traditional Books
2. Identifying Geometry 10 Grade Book
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Geometry 10 Grade Book
 - User-Friendly Interface
4. Exploring eBook Recommendations from Geometry 10 Grade Book
 - Personalized Recommendations
 - Geometry 10 Grade Book User Reviews and Ratings
 - Geometry 10 Grade Book and Bestseller Lists
5. Accessing Geometry 10 Grade Book Free and Paid eBooks
 - Geometry 10 Grade Book Public Domain eBooks
 - Geometry 10 Grade Book eBook Subscription Services

- Geometry 10 Grade Book Budget-Friendly Options
- 6. Navigating Geometry 10 Grade Book eBook Formats
 - ePub, PDF, MOBI, and More
 - Geometry 10 Grade Book Compatibility with Devices
 - Geometry 10 Grade Book Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Geometry 10 Grade Book
 - Highlighting and Note-Taking Geometry 10 Grade Book
 - Interactive Elements Geometry 10 Grade Book
- 8. Staying Engaged with Geometry 10 Grade Book
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Geometry 10 Grade Book
- 9. Balancing eBooks and Physical Books Geometry 10 Grade Book
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Geometry 10 Grade Book
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Geometry 10 Grade Book
 - Setting Reading Goals Geometry 10 Grade Book
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Geometry 10 Grade Book
 - Fact-Checking eBook Content of Geometry 10 Grade Book
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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