

Points, Lines, Planes, and Solids

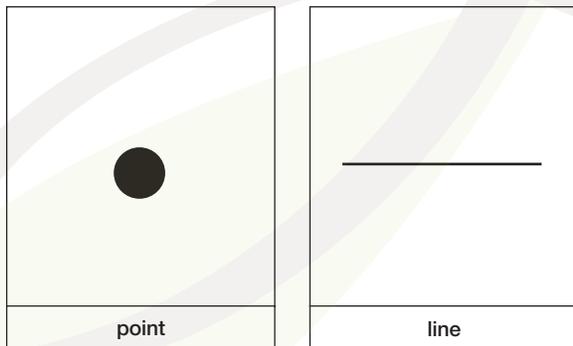
Background Information

This Background Information section introduces the most fundamental concepts and vocabulary of geometry. New terms are defined and illustrated in this section as well as on the NAMC's CSM for nomenclature cards.

Fundamental Geometric Units

All geometric shapes are made from four fundamental geometric units: point, line, plane, and solid.

- **Point:** A point is like a very tiny dot made by a very sharp pencil.
- **Line:** A line is like a very fine trace made by a very sharp pencil. A line may be straight, curved, or broken.



- **Plane:** A plane is a flat surface.
- **Solid:** A solid is anything that occupies space.

Did You Know?

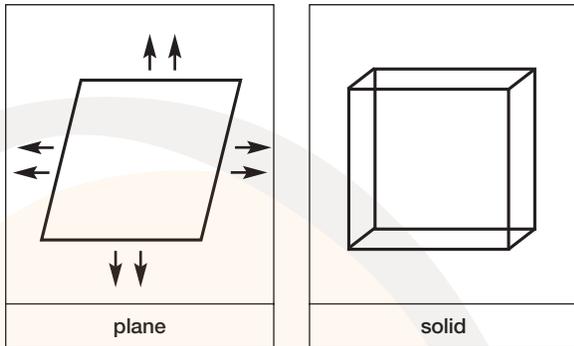


Even the most complex computer graphics begin with a simple point

A point, being the simplest geometric figure, is the basic building block for all other geometric objects.

Although a point has a position, it has no dimension at all (i.e., the thickness, length, and width of a point are zero). Yet, elementary geometry demonstrates how many figures are defined as a set of points with certain characteristics. This can be easily seen in planes and solids, as the points allow us to analyze and quantify their properties and relationships.

In today's rapidly expanding high-tech world, points are indispensable for creating computer graphic displays and geometric models. Geometric shapes and the interactions between these shapes are the basic foundation for all video games. Video games rely extensively on the use of geometric shapes like circles, squares, ovals, rectangles, trapezoids, and many more. All the graphics that you see on your computer or TV screens started with a simple point.

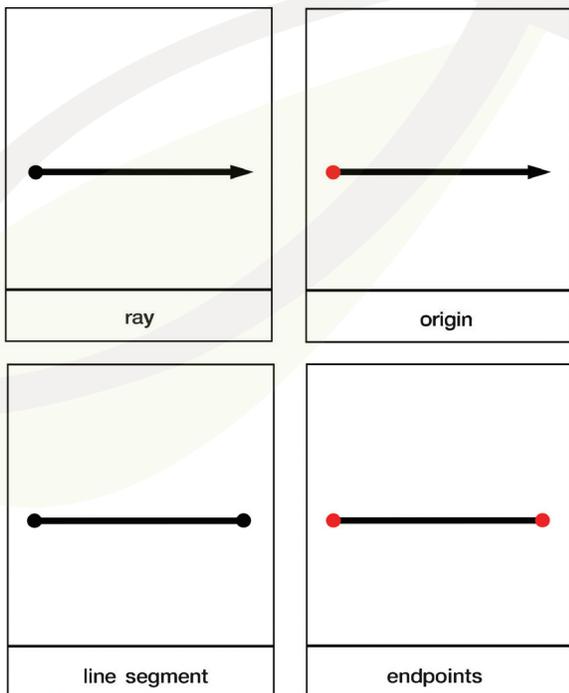


In geometry, the term “line” is generally understood to refer to a straight line unless otherwise stated. A more general mathematical term that includes straight lines as well as curved lines is “curve.” However, to avoid confusing young students, the term “curve” is not used this way in this manual.

Parts of a Line

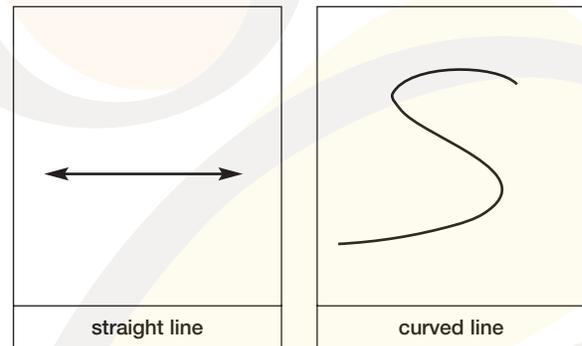
A line has the following parts:

- **Ray:** A ray is part of a straight line. A ray begins at a point and extends forever in one direction.



- **Origin:** An origin is the point at which a ray begins.
- **Line Segment:** A line segment is part of a straight line. It extends between two endpoints.
- **Endpoints:** Endpoints are the two points that limit a line segment.

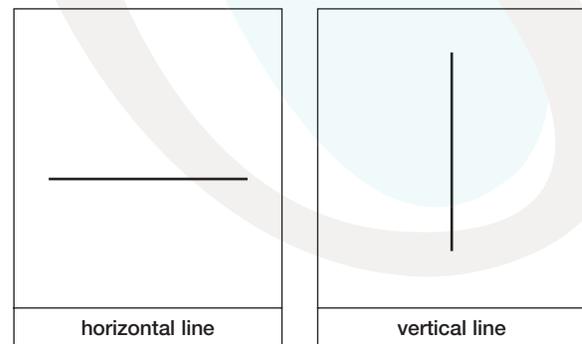
Types of Lines



Lines may be described according to their shape:

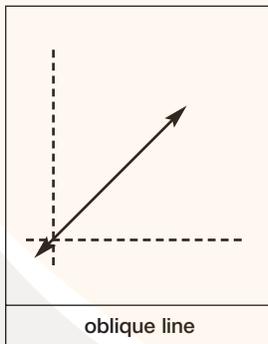
- **Straight Line:** A straight line extends in the same direction along its entire length.
- **Curved Line:** A curved line changes direction gradually along its length.

Lines may also be described in terms of their orientation, meaning their position with respect to the horizon or to another reference such as a page.



- **Horizontal Line:** A horizontal line is parallel to the horizon. Horizontal lines are usually drawn straight across the page.

- **Vertical Line:** A vertical line is at right angles to the horizon. It is upright. Vertical lines are usually drawn straight up and down the page.



- **Oblique Line:** An oblique line is a straight line that is neither horizontal nor vertical.

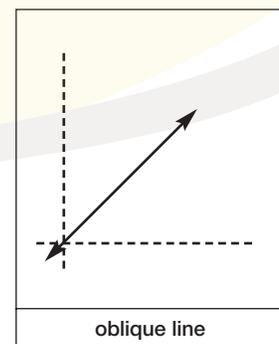
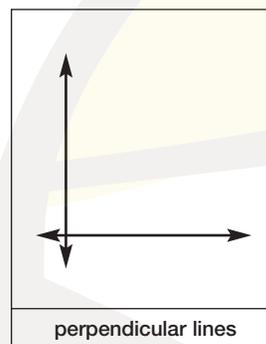
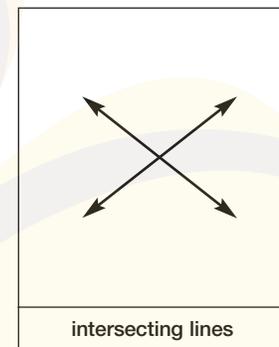
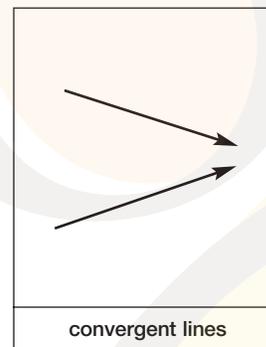
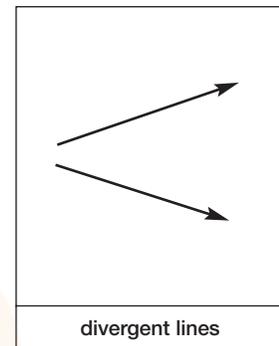
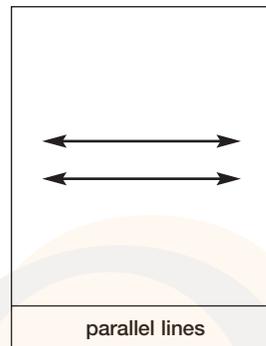
Relationships Between Lines

Another important geometric concept is the relationship between one line and another:

- **Parallel Lines:** Parallel lines are lines in the same plane that are the same distance apart at every point. They never meet.

- **Divergent Lines:** Divergent lines are straight lines in the same plane that get farther and farther apart as they are extended.

- **Convergent Lines:** Convergent lines are straight lines in the same plane that get closer and closer together as they are extended.



- **Intersecting Lines:** Intersecting lines are straight lines in the same plane that share a point.

- **Perpendicular Lines:** Perpendicular lines are intersecting lines that cross at right angles. All the angles are equal.

- **Oblique Lines:** Oblique lines are lines that are neither parallel nor perpendicular.

ACTIVITY 7

Understanding Relationships Between Lines: Intersecting, Perpendicular, and Oblique Lines



Understanding relationships between lines

Purpose

To learn about intersecting, perpendicular, and oblique lines.

Material

Geometry Sticks.

Cards with two-headed red arrows.

Nomenclature cards (see NAMC's CSM).

Math journals and pencils.

Presentation

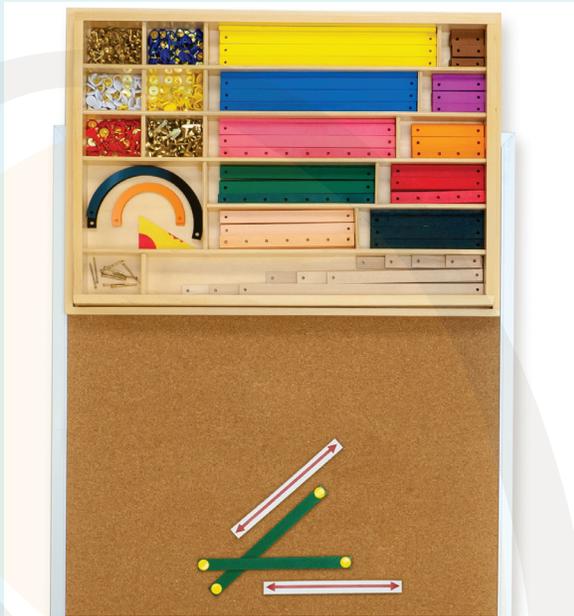
- Most Montessori teachers present this concept in Year 1 and review it in Years 2 and 3.
- Invite a student to learn about intersecting, perpendicular, and oblique lines at a table or mat with the material already laid out.



Setting up the material to represent intersecting lines

Intersecting Lines

- Invite the student to take a long stick and fix it to the tack board in a horizontal position.
- Encourage the student to choose two short sticks of different lengths and place them above and perpendicular to the first stick, with the longer of the two sticks on the right.
- Invite the student to place a second long stick along the top of the two short sticks so it crosses the first long stick.
- Point out that the lines intersect, meaning they meet or cross. State that they are called intersecting lines. Intersecting lines are straight lines in the same plane that share a point.



Intersecting lines cross each other

- Invite the student to place a card with a two-headed arrow by each of the sticks. Explain that the lines extend forever in both directions, yet intersect just once.

Perpendicular Lines



Perpendicular lines meet or cross at right angles

- Invite the student to take two equal-length sticks and fix them together in about the middle to make square corners. Explain that square corners are called right angles.
- Explain that the measuring angle is like the corner of a square and the student can use it to check that the sticks are at right angles.
- Encourage the student to use the measuring angle to check that the sticks are at right angles and adjust them if necessary.



The measuring angle is used to verify right angles

- Tell the student that lines that are at right angles to each other are called perpendicular lines. Perpendicular lines are intersecting lines that cross at right angles.

Oblique Lines

- Invite a student to take two long sticks and join them together at about the

center, placing the top stick in a diagonal position. Invite the student to fix the sticks to the board with tacks.

- Ask the student if these lines meet at right angles. (No.) In other words, are they perpendicular? (No.)
- Ask the student if these lines are parallel. (No.)
- Ask the student if one line is slanted compared to the other. (Yes.)
- Ask the student if she/he recalls the name for a line that is slanted. If necessary, help the student recall the term oblique.



Oblique lines do not make a right angle

- Tell the student that the term oblique is also used for two lines that are neither perpendicular nor parallel to each other. They are called oblique lines.
- Conduct a three-period lesson to reinforce the concepts of intersecting, perpendicular, and oblique lines. The nomenclature cards may be used for the three-period lesson.
- Ask the student to draw and label intersecting, perpendicular, and oblique lines in his/her journal.

Extensions

- Working independently or with a classmate, practice matching the nomenclature cards for intersecting, perpendicular, and oblique lines. Check work for accuracy using the control set.
- Look in the classroom, schoolyard, home, or elsewhere for intersecting, perpendicular, and oblique lines. List two examples of each in the math journal.