2 Lines and Angles

Why This Chapter Matters

Have you ever wondered how a spider builds its perfectly symmetrical web? Or how an architect designs a towering skyscraper that doesn't fall over? The secret lies in the simple, yet powerful, world of lines and angles. From the roads we travel on to the video games we play, these basic geometric ideas are the building blocks of everything around us. What is the sharpest angle you can find in your classroom? What is the widest? This chapter will unlock the secrets of these fundamental shapes.

Meet EeeBee.AI

Hi, I'm EeeBee! I love finding patterns and solving puzzles. Geometry is like the ultimate puzzle of the universe! From the tiniest atom to the largest galaxy, lines and angles are everywhere. I'll be your guide on this exciting journey. I'll pop in with fun facts, helpful hints, and tricky questions to make sure your brain gets a good workout.

Learning Outcomes

By the end of this chapter, students will be able to:

- Identify and define basic geometric elements like points, lines, line segments, and rays.
- Differentiate between parallel, intersecting, and concurrent lines.
- Classify different types of curves and angles (acute, obtuse, right, etc.).
- Measure and draw angles accurately using a protractor.
- Apply your understanding of lines and angles to simple design and construction tasks.

From Last Year's Notebook

- When we learned about basic shapes like squares, rectangles, and triangles?
- We used to talk about their "**sides**" and "**corners.**"
- Now, we'll learn the proper geometric names: what you called "**sides**" are line segments, and "**corners**" are angles.
- You already know how to measure length with a ruler.
- In this chapter, we will learn to measure angles precisely with a new tool: the protractor.
- Get ready to look closer at lines and explore the different types of angles!

Real Math, Real Life

Have you ever wondered where math is used outside the classroom? Lines and angles are a perfect example. They are a secret tool used by professionals in many exciting fields.

- **In Construction & Engineering:** To design strong bridges and straight roads.
- **In the Sky:** To help pilots navigate airplanes from one city to another.
- **In Art & Design:** To give drawings and paintings a 3D look (this is called perspective!).
- **On the Sports Field:** To calculate the perfect angle for a winning goal or a basket.

Quick Prep

1. Look at the ceiling of your classroom. Can you see where two walls meet? What does that meeting place look like?
2. If you stretch a rubber band between two fingers, what have you created?
3. How is a beam of light from a torch different from the edge of your ruler?
4. Can you draw two lines on a paper that will never, ever meet? What do we call them?
5. Think of a railway track. What can you say about the two rails?
6. If three friends stand in a perfect straight line, what is the geometric term for their positions?

Introduction

Welcome to the starting point of our geometric adventure! Before we can build magnificent structures or solve complex puzzles, we must first understand the basic building blocks. In this section, we will explore the simplest elements of geometry: points, lines, line segments, and rays. We will learn how these elements relate to each other, forming the foundation for all the shapes and figures you see around you. Think of it as learning the alphabet before you can write a story.

Chapter Overview

In this chapter, we will explore the fascinating world of geometry. Here's a map of what you will learn:

- **The Basics:** We'll start with the fundamentals: points, lines, line segments, and rays.
- **Line Relationships:** Discover how lines can intersect, run parallel, or meet at a single point.
- **Exploring Curves:** Learn to identify different types, such as open and closed curves.
- **All About Angles:** You'll measure angles with a protractor, identify types (acute, right, obtuse), and understand special pairs like complementary and supplementary angles.
- **Real-World Geometry:** See how these concepts are used in architecture, maps, and art.

From History's Pages

The story of geometry began with ancient civilizations like Egypt, where it was used for practical tasks like surveying land after the Nile River flooded. They used basic concepts like straight lines and right angles to redraw boundaries. However, it was the Greek mathematician Euclid, the "Father of Geometry," who turned it into a formal science around 300 BCE. In his book "Elements," he defined points and lines, creating a system that forms the foundation for our modern understanding of geometry today.

Basic Geometrical Figures

Everything in geometry starts with a point. A point is just a location in space, like a dot on a page. When you connect points, you create lines. But there are different kinds of lines! A line goes on forever in both directions. A line segment is a small piece of a line with a definite start and end. A ray is a mix of both—it has a starting point but then goes on forever in one direction, just like a sunbeam. We will explore each of these fundamental building blocks.

Sub-concepts to be covered

1. Point
2. Line
3. Line Segment
4. Ray
5. Triangle
6. Quadrilaterals
7. Circle
8. Polygons
9. Parallel Lines
10. Intersecting Lines
11. Concurrent Lines
12. Collinear Points

Point

A point has no size, length, or width. It simply represents a location or position in space. It is usually shown as a small **dot**.

Fig. 2.1

Line

A line is a straight path that extends infinitely in both directions. It has no thickness, and we typically represent it by two points (e.g., AB) to define it.

Fig. 2.2

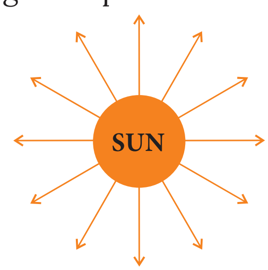
Line Segment

A line segment is part of a line that has two definite **endpoints**. Unlike a line, it does not extend infinitely.

Fig. 2.3

Ray

A ray starts at a point (**called the origin**) and extends infinitely in one direction. It is represented by a single endpoint and an arrowhead at the other end.



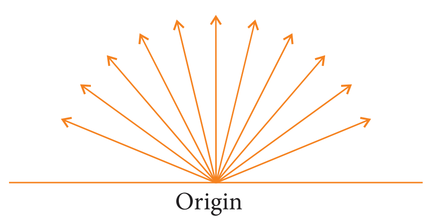


Fig. 2.4

Torch

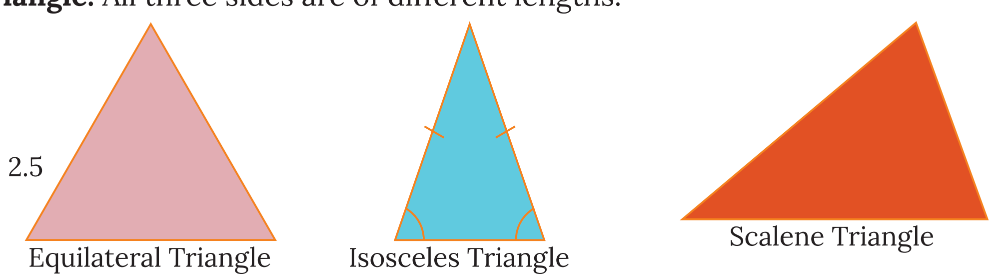
Triangle

A triangle is a polygon with three **sides** and three **angles**.

Types of triangles based on side lengths:

- **Equilateral Triangle:** All three sides are equal.
- **Isosceles Triangle:** Two sides are equal.
- **Scalene Triangle:** All three sides are of different lengths.

Fig. 2.5



Quadrilaterals

A quadrilateral is a polygon with **four sides**.

Common types

- **Square:** All sides equal, and all angles are 90°.
- **Rectangle:** Opposite sides are equal, and all angles are 90°.
- **Parallelogram:** Opposite sides are parallel and equal in length.
- **Rhombus:** All sides are equal, but angles are not 90°.
- **Trapezium:** One pair of opposite sides is parallel.

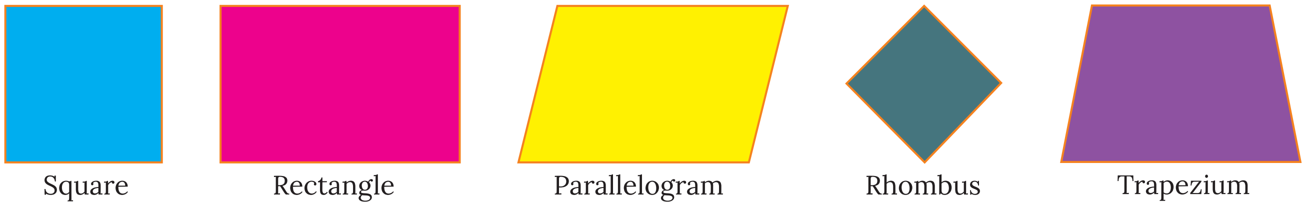


Fig. 2.6

Circle

A circle is a set of points in a plane that are at an equal distance from a fixed point called the center. The distance from the center to any point on the circle is called the radius.

Polygons

A polygon is a closed figure with straight sides. Based on the number of sides, polygons are named differently:

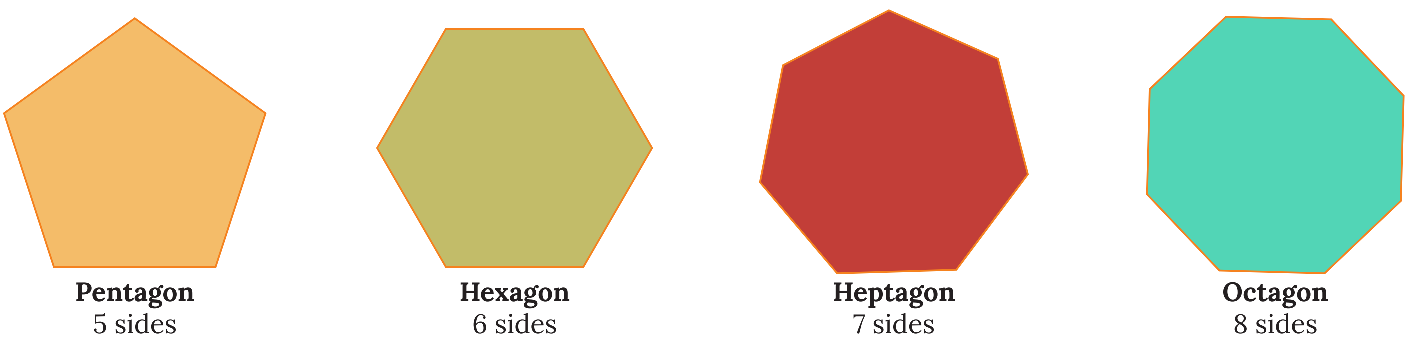


Fig. 2.7

Parallel Lines

- Parallel lines are lines that never meet, no matter how far they are extended in either direction.
- They always remain the same **distance** apart and have the same **slope**.
  - **Example:** The opposite sides of a rectangle are parallel.
  - **Notation:** Parallel lines are denoted by the symbol "**||**". For example, if line ***l*** is parallel to line **m**, we write ***l*** **|| m**.

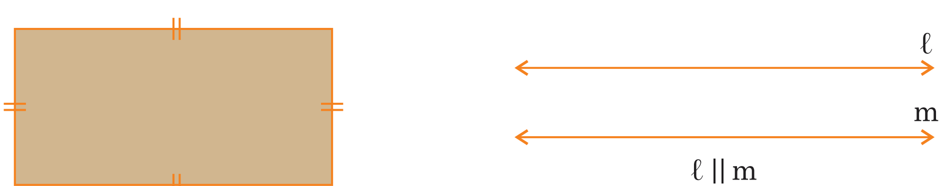


Fig. 2.8

Intersecting Lines

- Intersecting lines are lines that meet or cross each other at a single point.
- The point where they meet is called the point of intersection.
  - ♦ **Example:** Two roads crossing each other at a street corner are intersecting lines.

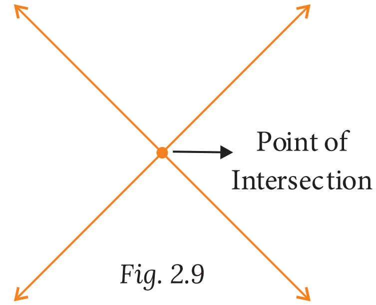


Fig. 2.9

Concurrent Lines

- Concurrent lines are three or more lines that all meet or intersect at a single point.
- This common point is known as the point of concurrency.
  - ♦ **Example:** The medians of a triangle are concurrent, as they meet at the centroid of the triangle.

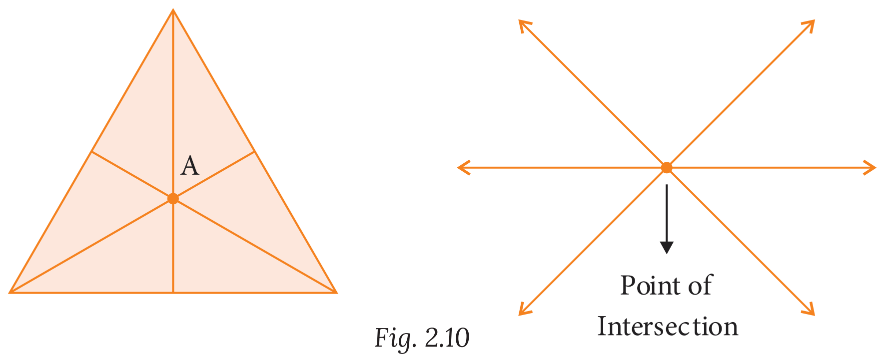


Fig. 2.10

Collinear Points

- Collinear points are points that lie on the same straight line.
- In other words, if you can draw a single straight line that passes through all the points, those points are said to be **collinear**.
  - ♦ **Example:** Points A, B, and C are collinear if they lie on the same line.

(i) Collinear point *Fig. 2.11* (ii) Non-Collinear point

Example 1 : Use **Fig 2.12** to name:

(i) Six points

(ii) A line

(iii) Four rays

(iv) Five line segments

(v) Two rays with initial point C

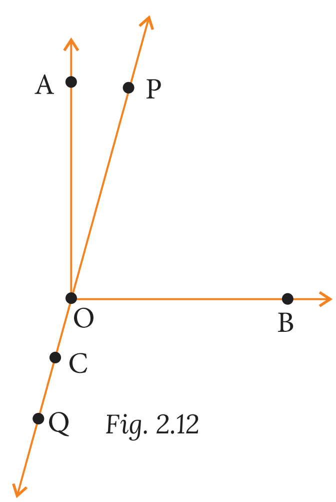


Fig. 2.12

Solution: (i) Six points are A, B, C, Q, P, and O

(ii) $\overleftrightarrow{PQ}$

(iii) $\overrightarrow{OP}$, $\overrightarrow{OA}$, $\overrightarrow{OB}$, $\overrightarrow{OQ}$

(iv) $\overline{QO}$, $\overline{QC}$, $\overline{OA}$, $\overline{OP}$, $\overline{OB}$

(v) $\overrightarrow{CP}$, $\overrightarrow{CQ}$

Example 2 : Observe **Fig. 2.13** and answer the following questions:

(i) Name all the rays whose initial points are A, B, and C respectively.

(ii) Is ray AB different from ray BA?

(iii) Is ray BC different from ray CB?

Fig. 2.13

Solution: (i) Rays with initial point A are AB, AC, AD, and AE.

Rays with initial point B are BA, BC, BD, and BE.

Rays with initial point C are CA, CB, CD, and CE.

(ii) A ray is defined by its origin and direction. Ray AB and Ray BA are different; they extend in opposite directions.

(iii) Rays BC and CB are different, because they have different initial points (B and C).

Example 3 : From the adjoining **figure 2.14**, answer the following questions:

(i) Name all pairs of parallel lines.

(ii) Name all pairs of intersecting lines.

(iii) Name the lines whose point of intersection is Q.

(iv) Name the lines containing point O.

(v) Name the collinear points.

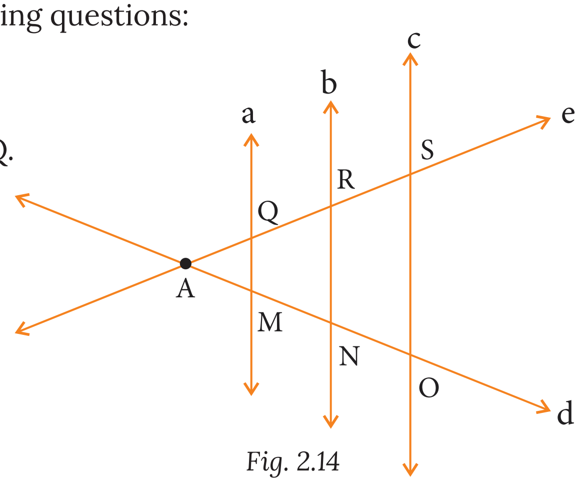


Fig. 2.14

Solution: (i) a || b, b || c, a || c — valid if the diagram shows three distinct parallel lines.

(ii) The listed intersecting pairs are with d and e.

(iii) Lines a and e intersect at Q.

(iv) Lines c and d contain point O.

(v) Points Q, R, and S are collinear. Also, points A, M, N, and O are collinear.

Knowledge Checkpoint

- What is the main difference between a line and a ray?
- Can a line segment be part of a line?
- How many endpoints does a line have?
- What is the minimum number of lines needed to be concurrent?
- Are the three vertices of any triangle ever collinear?

Key Terms

- **Intersecting Lines:** Lines that have one and only one point in common.
- **Parallel Lines:** Lines in a plane which do not meet, no matter how far they are extended.
- **Concurrent Lines:** Three or more lines that pass through the same single point.
- **Collinear Points:** Points that all lie on the same straight line.

Do It Yourself

Imagine you are a dot (a point) living in a one-dimensional world (a line). You can only move forward and backward. You have no concept of "**up**" or "**down**." What would your world be like? How would you describe another dot that is not on your line?

Activity

String Geometry

Objective: To physically model lines, line segments, and rays.

Materials: A ball of string, scissors, two students (Student A and Student B).

Procedure:

1. **Line Segment:** Student A and Student B stand apart. They hold a piece of string taut between them. Ask: "What does this represent?" (A line segment, because it has two endpoints - their hands).
2. **Ray:** Student A holds one end of the string. Student B takes the ball of string and walks away in a straight line, unspooling it. Ask: "What does this represent now?" (A ray, with Student A as the starting point).
3. **Line:** Discuss how you could represent a line. (It's impossible, as you can't go on forever in both directions!). This helps them understand the abstract nature of a line

Facts Flash

- The word "**line**" comes from the Latin word "**linea**," which originally meant a linen thread.
- The concept of points and lines extending to infinity led to the development of "**Projective Geometry**," where even parallel lines are said to meet at a "point at infinity."

Mental Mathematics

- If you have three points on a line, how many line segments can you name between them?
- If you have 2 parallel lines and a third line intersects both of them, how many points of intersection are there in total?
- I have three points. They are non-collinear. What shape do they form if I connect them with line segments?

Gap Analyzer™ Homework

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Exercise 2.1

1. **Observe the given figure and answer the following questions:**

   Which of the following pairs of lines/rays/line segments intersect?

   a) Two diagonal rays pointing in opposite directions.

   b) Two parallel line segments.

   c) Two perpendicular lines.

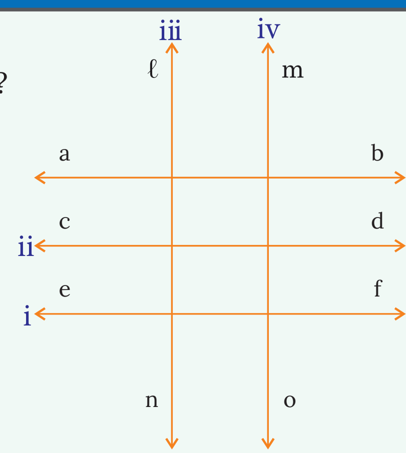
   d) Two line segments extended to intersect.

   e) Two non-parallel, non-intersecting rays.

   f) Identify pairs of parallel lines in the figure.

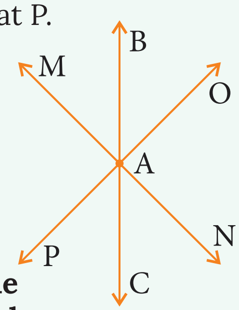
   g) In which diagrams are perpendicular lines visible?

   h) Do any two rays form a right angle? If yes, name the pair.



2. **Draw a rough figure and label suitably for each of the following cases:**
   a) Point A lies on line XY.
   b) $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at point O.
   c) Line ℓ contains points M and N.
   d) Rays PQ and PR meet at P.
   e) Three collinear points X,Y, and Z on line m.

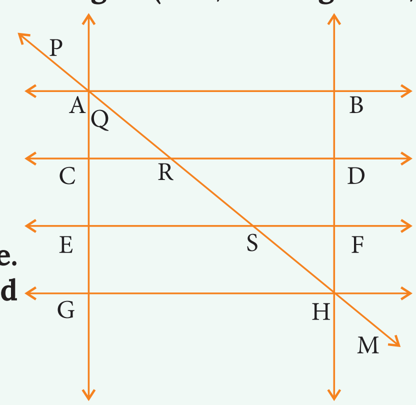
3. **Identify relationships in the diagram:**
   a) Name the point of intersection of two lines.
   b) Identify all collinear points.
   c) Determine if given points lie on the same line.



4. **Imagine you are drawing a map of the route from your house to your school. The main road is a long, straight line. Two smaller streets intersect this main road but never intersect each other. What geometrical term describes these two smaller streets in relation to each other? What do we call the point where one of these streets crosses the main road?**

5. **Look at an analog wall clock. When the time is exactly 3:00 PM, what type of angle (acute, right, or obtuse) is formed by the hour and minute hands? Now, imagine it is 3:30 PM. What type of angle do the hands form now? Describe the two lines that form these angles (line, line segment, or ray).**

6. **From Figure, answer the following questions:**
   a) Name all pairs of parallel lines.
   b) Name all pairs of intersecting lines.
   c) Name the lines whose point of intersection is M.



7. **Imagine you are a 'Geometry Detective' in your classroom or home. Your mission is to find hidden geometrical figures. Look around you and identify:**
   a) Two examples of parallel lines.
   b) Two examples of intersecting lines.
   c) One example of a square.
   d) One example of a circle.

8. **Look carefully at the image of the house below.**
   a) How many triangles can you see in the picture?
   b) How many quadrilaterals (like squares and rectangles) can you identify?
   c) Find and point to a pair of perpendicular lines on one of the windows.
   d) The top edge of the roof and the bottom edge of the house are what kind of lines?

Curves

In mathematics, a "**curve**" is any line that isn't necessarily straight. It's a continuous line drawn without lifting the pencil. We can classify curves in two main ways. First, is it open or closed? An **open curve** has two distinct endpoints, while a **closed curve** joins back to its starting point. Second, is it simple or non-simple? A simple curve never **crosses itself**, while a non-simple curve does. Let's explore these six categories.

Sub-concepts to be covered (Types of Curves)

1. Open Curve
2. Closed Curve
3. Simple Curve
4. Non-Simple Curve
5. Plane Curve
6. Space Curve

Mathematical Explanation

Open Curve

- An open curve does not form a **closed shape.**
  - **Example:** A wavy line or an arc.

Fig. 2.15

Closed Curve

- A closed curve forms a complete, **enclosed shape.**
  - **Example:** A circle or an oval.

Fig. 2.16

Simple Curve

- A curve that does not **cross itself**.
  - **Example:** A semicircle or a smooth "U"-shaped line.

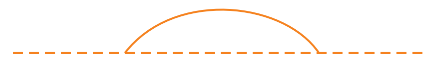


Fig. 2.17

Non-Simple Curve

- A curve that crosses itself at one or more points.
  - **Example:** A figure-eight or a loop.

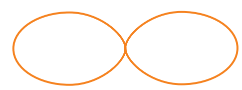


Fig. 2.18

Plane Curve

- A curve that lies completely on a flat surface **(plane)**.
  - **Example:** A circle, parabola, or ellipse.

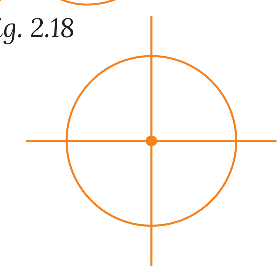


Fig. 2.19

Space Curve

- A curve that extends into three-dimensional space.
  - **Example:** A helix or spiral.


Fig. 2.20

Example 4 : Illustrate, if possible, each one of the following with a rough diagram:

(i) A closed curve made up entirely of circles.

(ii) An open curve made up entirely of arcs.

(iii) A closed curve made up of both straight lines and curved parts.

(iv) An open curve made up of both straight lines and curved parts.

Fig. 2.21

Knowledge Checkpoint

- What is the main difference between an open and a closed curve?
- Give an example of a simple open curve.
- Is a tangled ball of yarn a simple or non-simple curve?

Activity

String Doodles

Objective: To create and classify different types of curves.

Materials: A piece of string (about 30 cm long), paper, glue.

Procedure:

1. Take the string and drop it randomly onto the paper. Carefully glue it down.
2. Look at the shape it formed. Is it open or closed? Is it simple or non-simple?
3. Try again, but this time, intentionally try to make a simple closed curve.
4. Now, try to make a non-simple closed curve.
5. Discuss with a partner why each shape fits its classification.

Key Terms

- **Curve:** A continuous line drawn on a plane which is not required to be straight.
- **Open Curve:** A curve with endpoints that do not join.
- **Closed Curve:** A curve with no endpoints that completely encloses an area.
- **Simple Curve:** A curve that does not cross over itself

Facts Flash

A famous mathematical problem called the "**Jordan Curve Theorem**" states that every simple closed curve divides a plane into an "**inside**" and an "**outside**." It sounds obvious, but it's surprisingly difficult to prove mathematically!

Do It Yourself

Can you shade the "**inside**" of an open curve? Why or why not? What does a curve need to have in order to have a distinct inside and outside? This simple question gets to the heart of what it means for a shape to be "**closed**."

Mental Mathematics

- Think of the letters of the alphabet (in capitals). Which ones are open curves? (e.g., C, F, G, H...).
- Which letters are closed curves? (O, D).
- Which letters are a combination of curves and line segments? (e.g., B, P, R).

Gap Analyzer™ Homework

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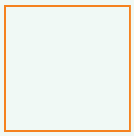
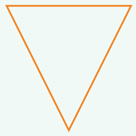
Exercise 2.2

1. **Identify the following curves as open or closed.**

a) 

b) 

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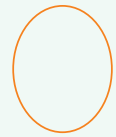
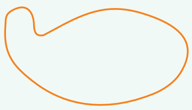
d) 

e) 

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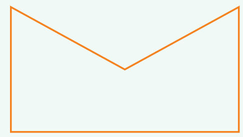
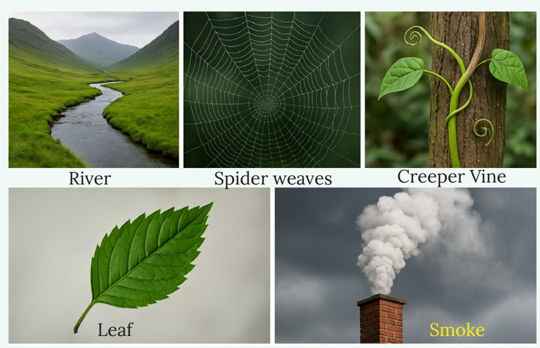
g) 

h) 

2. **Draw the following types of curves:**
   a) A closed curve made entirely of circles.
   b) An open curve made entirely of arcs.
   c) A closed curve made of both straight and curved parts.
   d) A simple curve that does not cross itself.
3. The compound wall that encloses your entire school campus can be thought of as a shape. Does this wall represent a closed curve? Your classroom is inside the campus and the main road is outside. Using the terms ‘interior’, ‘exterior’, and ‘boundary’, describe the location of your classroom, the main road, and the wall itself.
4. Imagine you are watching a car race on a standard oval track. The path a car takes to complete exactly one lap, starting and finishing at the same line, forms a curve. Is this an open curve or a closed curve? Explain why
5. **Here are some noteworthy facts you may have come across.**



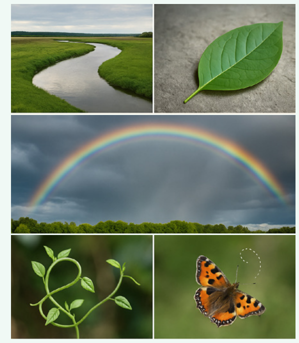
River Spider weaves Creeper Vine

Leaf Smoke

- A river flowing through a valley twists and turns but never comes back to join its starting point.
- A spider weaves a circular web around itself, forming loops that join back to the starting point.
- A creeper vine climbs a tree. At some points, its tendrils cross over themselves.
- The outline of a neem or mango leaf lies flat on paper when traced.
- When smoke rises from a chimney, it moves upward while swirling in space.

i. Why can the river’s path be considered an open curve?
ii. How is the web a closed curve?
iii. If one strand of the web breaks, will it remain closed? Why or why not
iv. Which part of the vine represents a simple curve?
v. Can you give another natural example of a plane curve?
vi. Can you think of another example of a space curve in nature?

6. **Check Yourself: Curves in Daily Life**
   - The river's flow makes an open curve as it travels across the land.
   - The outline of a leaf is a closed curve lying flat on a plane.
   - A rainbow in the sky is a simple curve because it does not cross itself.
   - The creeping path of a vine can be a non-simple curve when it overlaps.
   - The flight of a butterfly is a space curve, moving in all directions.



Questions on the Statement

i. Which type of curve is shown by the river Ganga's flow? Why?
ii. The lotus leaf outline is a closed curve. Can you draw and explain it?
iii. Why is a rainbow a simple curve, but the twisted path of a climbing vine is non-simple?
iv. Give another natural example of a space curve besides the flight of a butterfly.

7. **Your kitchen is full of curves! With permission from an adult, find and list or draw:**
   a) An object whose rim is a simple closed curve
   b) An object that represents an open curve .
   c) A utensil that is a closed curve but is NOT simple.

8. **Look at the English alphabet and the numbers 0-9.**
   a) List three letters that are open curves
   b List two letters that are simple closed curves
   c) Find one number that is a closed curve but is not simple.
   d) Write your first name in capital letters. Circle all the letters that are formed using only open curves.

Angles

An angle is formed when two rays meet at a common point. Angles are one of the fundamental concepts in geometry and are used to measure the amount of turning or rotation between two intersecting lines or rays.

Wall Clock

Scissors

Fig. 2.22

In our day-to-day life we observe many objects having two arms like two hands of a wall clock, two blades of a pair of scissors as shown in **Fig**.2.22, which form angles between them as and when their hands open.

Sub-concepts to be covered

1. Key Components of an Angle
2. Notation for an Angle
3. Measuring an Angle
4. Comparing Angles

Key Components of an Angle

1. Vertex

- The common endpoint where two rays meet is called the **vertex of the angle**.
  - ♦ **Example:** In angle ∠ABC, B is the vertex.

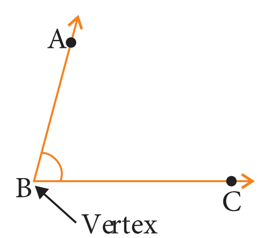


Fig. 2.23

2. Arms

- The two rays that form the angle are called the **arms** or **sides of the angle**.
  - ♦ **Example:** In ∠ABC, the rays BA and BC are the arms.

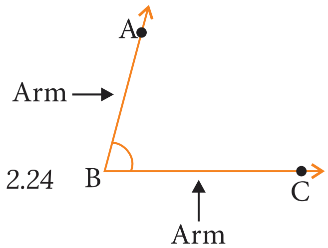


Fig. 2.24

3. Angle

- The space or turning effect between the two arms is the angle.
  - **Examples** of Angles in Everyday Life

  (i) The hands of a clock at 3:00 form a right angle.

  (ii) The hands of a clock at 10:10 form an acute angle.

  (iii) The corner of a book forms a right angle.

  (iv) A fully open door forms a straight angle.

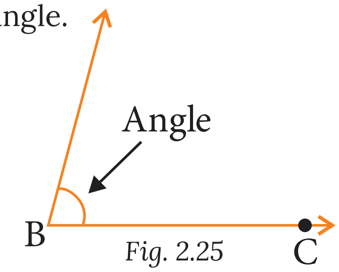


Fig. 2.25

(i) (ii) (iii) (iv)

Fig. 2.26

Notation for an Angle

Angles are represented and named in a specific way to avoid confusion. Here's how angles are commonly denoted:

Using Three Points

An angle is named by three points:

- The middle point is always the vertex of the angle.
- The other two points are on the arms of the angle.

Example 5 : If A, B, and C are points, where B is the vertex, the angle is written as: ∠ABC or ∠CBA

In this notation, B is the vertex.

AB and BC are arms.

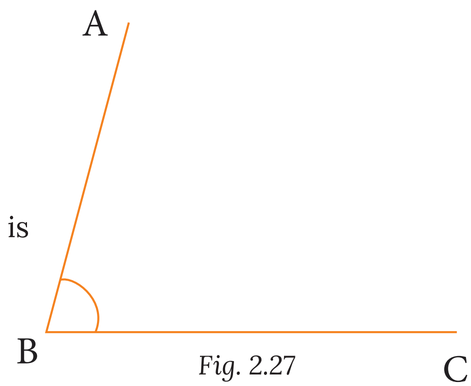


Fig. 2.27

Measuring an Angle

Angles are measured in degrees (°), which represent the amount of rotation or turning between two rays that form the angle. To measure angles, we use a tool called a protractor.

Steps to Measure an Angle

1. Place the Protractor

- Align the center hole (marked as 0 or center) of the protractor with the vertex of the angle.
- Place the baseline of the protractor along one of the arms of the angle.

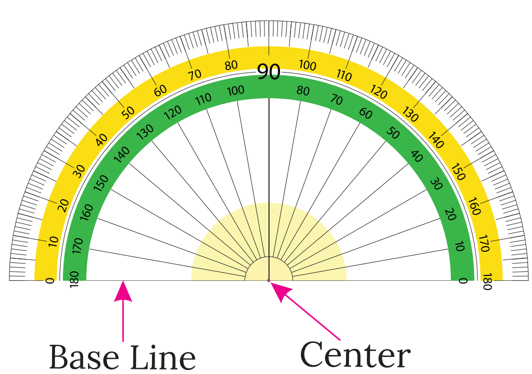


Fig. 2.28

2. **Identify the Scale**

- Protractors have two scales: an inner scale and an outer scale.
- Decide which scale to use based on how the angle is positioned. Start reading from the scale where the baseline aligns with 0.

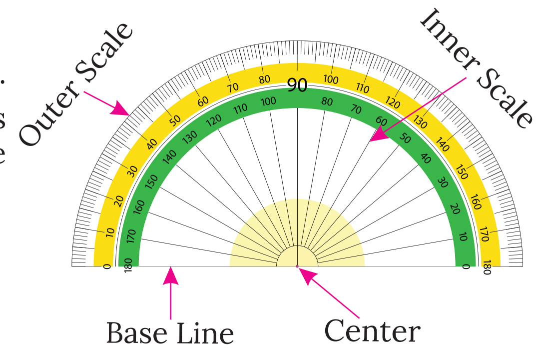


Fig. 2.29

3. **Read the Measurement**

- Follow the other arm of the angle to where it intersects the protractor's scale.
- Note the value on the protractor where the arm crosses the scale. This is the measure of the angle.

Using a Protractor:

- Draw an angle of 45°, 90°, and 135° using a protractor.

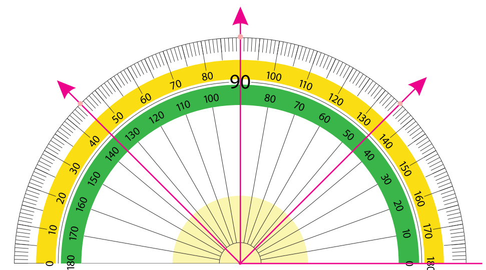


Fig. 2.30

A Pinch of History

- The concept of measuring angles originated from ancient civilizations. The Babylonians were the first to divide a circle into 360 degrees based on their base-60 number system. This system laid the foundation for modern angle measurement.
- The Greeks further studied geometry, with famous mathematicians like Euclid defining angles and their properties in "**The Elements**."
- Today, we continue using the degree as a standard unit of angle measurement.

Unlabelled Protractor

An unlabelled protractor is a basic protractor without any degree markings. It can be used for activities like:

1. Drawing freehand angles and estimating their degree measure.
2. Identifying types of angles visually (e.g., acute, obtuse).

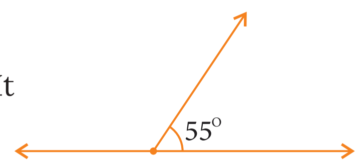


Fig. 2.31

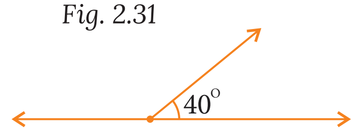


Fig. 2.32

Activity with an Unlabelled Protractor:

- Draw an angle using the protractor and classify it (e.g., acute, right, or obtuse).
- Estimate the angle measure using your eyes.

Labelled Protractor

A labelled protractor is marked with degree values ranging from 0 to 180 on both inner and outer scales. It is used for accurate angle measurement and drawing.

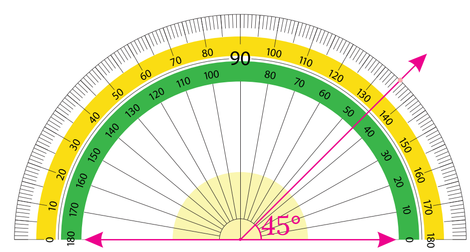


Fig. 2.33

Degree Measure of an Angle

The degree measure of an angle represents the amount of rotation or turn between two rays that form the angle. The unit of measurement for angles is degrees, denoted by the symbol (°).

What is a Degree?

- A degree is a unit of measurement used to measure angles.
- A full rotation around a point is divided into 360 equal parts, where each part is called 1 degree.
- $1° = \frac{1}{360}$ of a complete rotation.

How to Measure Angles in Degrees

1. **Using a Protractor**

- Align the center hole of the protractor with the vertex of the angle.
- Place the baseline of the protractor along one ray of the angle.
- Measure the angle where the other ray intersects the scale on the protractor.
- The measurement is given in degrees.

2. **Standard Units:**

   - 90° is a right angle.
   - 180° is a straight angle.
   - 360° is a complete angle.

Comparison of Angles

The comparison of angles involves determining which angle is larger, smaller, or if they are equal. Angles can be compared based on their degree measure, which is the amount of rotation between the two rays forming the angle.

How to Compare Angles

1. **Using Degree Measure**

Sometimes, we compare two angles simply by measuring their degree values. A larger degree measure indicates a wider opening between the arms of the angle. This method provides an accurate way to determine which angle is greater.

However, when the difference between two angles is small, visual comparison alone may not be reliable. In such cases, using a protractor or calculating the angles mathematically ensures precision.

Example 6 :

- ♦ An angle of 120° is clearly larger than an angle of 45° because it has a greater opening.
- ♦ But when comparing 88° and 90°, the difference is small, and measuring precisely is necessary.

2. **Using a Protractor**

- Measure each angle using a protractor.
- Compare the degree measures of the angles.
  - ♦ **Example :** $\angle A = 70°$, $\angle B = 110°$. Therefore, $\angle B > \angle A$

3. **Visually Comparing Angles**

When comparing two angles visually, we can use tracing to determine their relative sizes. This method involves copying one angle onto tracing paper and aligning it with another angle for comparison.

Steps for Comparison

1. Trace one of the angles onto a transparent sheet.
2. Place the traced angle over the second angle, ensuring that one arm of both angles coincides.
3. Observe the position of the other arm:
   - ♦ If the traced arm lies inside the second angle, the first angle is smaller.
   - ♦ If both arms align perfectly, the angles are equal.
   - ♦ If the traced arm lies outside the second angle, the first angle is larger.

Example 7 :

- ♦ If $\angle ABC$ is traced and placed over $\angle DEF$, and its other arm falls within $\angle DEF$, then $\angle ABC < \angle DEF$.
- ♦ If the arms overlap completely, $\angle ABC = \angle DEF$.
- ♦ If the traced arm extends beyond $\angle DEF$, then $\angle ABC > \angle DEF$.
- ♦ This method provides a quick way to compare angles, but for accurate results, using a protractor is advisable.

Example 8 : How many angles are in the given **Fig. 2.34** Name them.

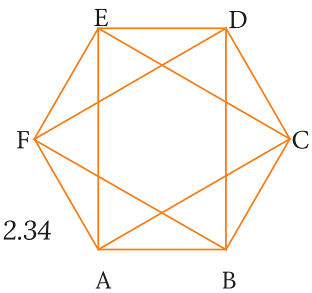


Fig. 2.34

Solution: There are six angles, and their names are:

(i) ∠ABC	(ii) ∠BCD	(iii) ∠CDE
(iv) ∠DEF	(v) ∠EFA	(vi) ∠FAB

Example 9 : In **Fig. 2.35**, write another name for the following angles:

(i) ∠1	(ii) ∠2	(iii) ∠3
(iv) ∠4	(v) ∠5	(vi) ∠6
(vii) ∠7	(viii) ∠8	

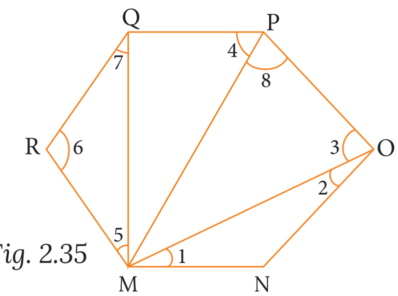


Fig. 2.35

Solution:

(i) ∠1 = ∠NMO or ∠OMN	(ii) ∠2 = ∠MON or ∠NOM
(iii) ∠3 = ∠MOP or ∠POM	(iv) ∠4 = ∠MPQ or ∠QPM
(v) ∠5 = ∠RMQ or ∠QMR	(vi) ∠6 = ∠MRQ or ∠QRM
(vii) ∠7 = ∠RQM or ∠MQR	(viii) ∠8 = ∠MPO or ∠OPM

Example 10 : Explain why ∠AOD cannot be labeled as ∠O in the given **Fig. 2.36**

Solution: In the **Fig. 2.36**, there are four different angles being formed at vertex O, namely, ∠AOB, ∠BOC, ∠COD, and ∠DOA. So, ∠O is not an appropriate label for ∠AOD because there is no distinct angle represented by ∠O.

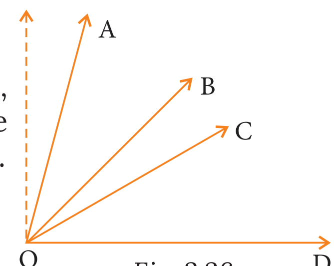


Fig. 2.36

Example 11 : Which angle is greater: ∠XOY or ∠AOB? Give reasons.

Solution: By observing the **Fig. 2.37**, we can say ∠XOA is greater than ∠AOB.

Adding the common angle ∠AOY to both gives

∠XOY = ∠XOA + ∠AOY > ∠AOB = ∠BOY + ∠AOY

We get ∠XOY is greater than ∠AOB.

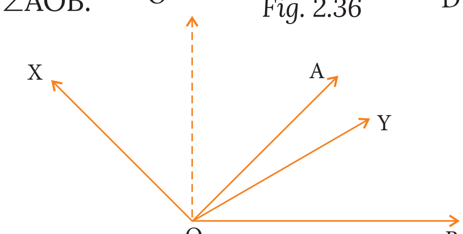


Fig. 2.37

Knowledge Checkpoint

- What are the two parts of an angle called?
- To measure an angle, where do you place the center of the protractor?
- An angle measures 110°. Another angle measures 80°. Which one is larger?

Facts Flash

A degree can be subdivided into smaller parts! Just like an hour is divided into 60 minutes, a degree is divided into 60 'minutes of arc' (or arcminutes). And each arcminute is divided into 60 '**seconds of arc**' (or arcseconds). These tiny measurements are used in astronomy and navigation.

Do It Yourself

You have a clock. The minute hand moves 360° in 60 minutes. How many degrees does the minute hand move in just one minute? What about the hour hand? It moves 360° in 12 hours. How many degrees does the hour hand move in one minute? It's much, much slower!

Activity

Body Angles

Objective: To understand angle measure through physical movement.

Materials: Your own body!

Procedure:

1. Stand with your arms straight down at your sides (0°).
2. Raise one arm straight out in front of you, parallel to the floor. What angle have you made with your body? (A right angle, 90°).
3. Raise the arm straight up, pointing to the ceiling. What angle is this? (A straight angle, 180°).
4. Try to make a 45° angle (an acute angle) and a 135° angle (an obtuse angle) with your arms.
5. Work with a partner to check each other's "body angles."

Key Terms

- **Angle:** A figure formed by two rays sharing a common endpoint.
- **Vertex:** The common endpoint of the two rays that form an angle.
- **Arms (or Sides):** The two rays that make up an angle.
- **Degree (°):** The standard unit used to measure angles.
- **Protractor:** A tool used for measuring and drawing angles.

Mental Mathematics

- What is half of a right angle? (45°)
- What is double a right angle? (180°)
- An angle is 20°. How many more degrees do you need to make it a right angle? (70°)
- I am an angle. I am 10 degrees less than a straight angle. What am I? (170°)
- A circle is 360°. A semi-circle is how many degrees? (180°)

Gap Analyzer™ Homework

Watch Remedial

Exercise 2.3

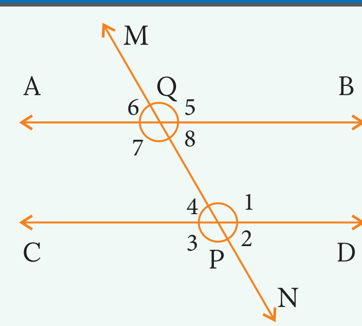
1. **Draw and label an angle with arms AB and AC.**
2. **In the given Fig., write another name for the following angles:**

   a) ∠1 b) ∠2

   c) ∠3 d) ∠4

   e) ∠5 f) ∠6

   g) ∠7 h) ∠8



3. **Draw the following angles using a protractor:**

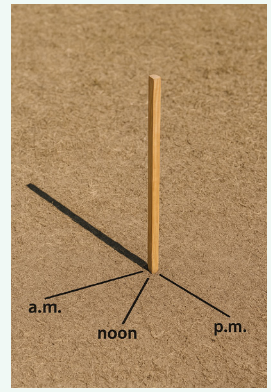
   (i) 45°, 60°, 90° (ii) 135°, 120°, 160°

4. **On a sunny day, take a ruler or a straight stick and place it upright in the ground.**

   i. Observe the shadow it casts in the morning (around 9 AM). What type of angle (acute, obtuse, or right) is formed between the stick and its shadow on the ground?

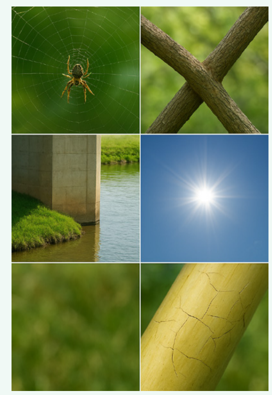
   ii. Observe the shadow again at noon. How has the angle changed?

   iii. Observe the shadow one last time in the afternoon (around 3 PM). Compare the angle now to the one from the morning. Draw a simple diagram showing the stick and the three shadows you observed, labeling the angles. What can you conclude about how angles are related to the time of day and the sun's position?



5. **Here are some noteworthy facts you may have come across.**

   - A spider was sitting at the center of its web, where many lines (threads) met.
   - Two tree branches crossed each other, forming an X-shape.
   - A riverbank and a bridge pillar stood at a perfect right angle.
   - The sun's rays spread out from a point in the sky like straight lines.
   - A bamboo stick had tiny cracks running in different directions, forming angles.



   Questions:

   i. What is formed when many lines (threads) meet at the center of the

   ii. What type of lines are formed when the tree branches cross each other in an X-shape?

   iii. What type of angle is formed between the riverbank and the bridge pillar?

   iv. Which natural object in the passage shows rays spreading from a single point?

6. **Identify and classify the angles in a clock:**

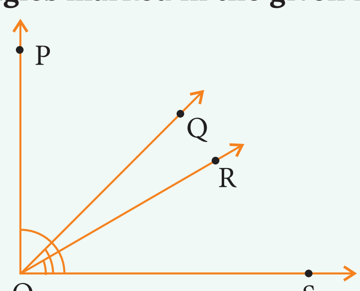
   a) The angle at 3:00.

   b) The angle at 1:00.

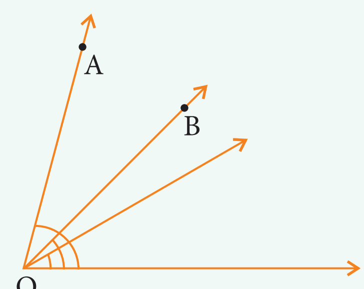
   c) The angle at 10:10.

(a) (b) (c)

7. **Name all the angles marked in the given figure.**



(a)



(b)

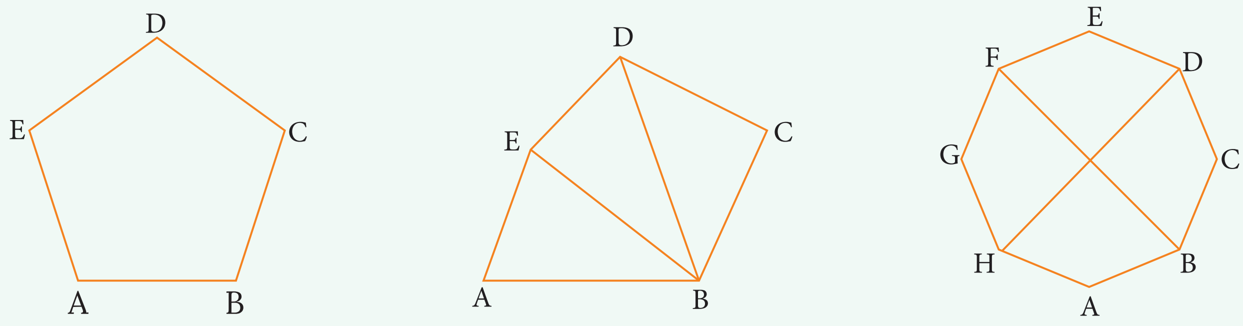
8. **Look at the drawing of the playground slide.**

   i. Identify the type of angle formed between the ladder and the ground.

   ii. Identify the type of angle formed between the slide and the ground.

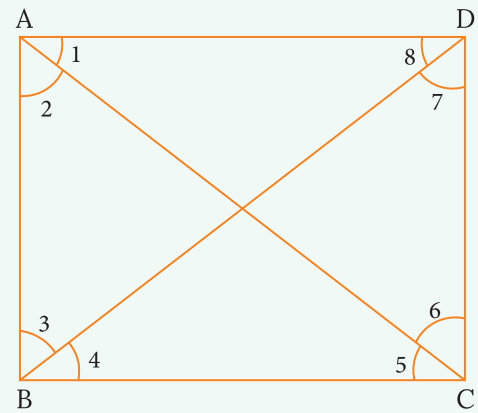
   iii. At the very top of the structure, what type of angle is formed between the ladder and the slide?

9. **Name all the angles in the given figure.**



(a) (b) (c)

10. **Answer the following questions on the basis of figure:**



   a) Write the name for ∠2, ∠4, ∠6, ∠8
   b) Name the Vertex of ∠5, ∠7, ∠3
   c) Which is the common arm of
      (i) ∠1 and ∠2 (ii) ∠5 and ∠6

Types of Angles and Angle Pairs

Not all angles are the same. Some are small and sharp, others are wide and open. We classify angles based on their size in degrees. We'll learn the names for each type: acute, right, obtuse, straight, reflex, and complete. Furthermore, angles often come in pairs that have special relationships. We will investigate complementary pairs (that add up to 90°), supplementary pairs (that add up to 180°), adjacent angles (that are neighbors), and vertically opposite angles (that are formed by intersecting lines).

Sub-concepts to be covered

1. **Special Types of Angles**
   - **Acute Angle:** An angle greater than 0° and less than 90°.
   - **Right Angle:** An angle that is exactly 90°.
   - **Obtuse Angle:** An angle greater than 90° and less than 180°.
   - **Straight Angle:** An angle that is exactly 180°.
   - **Reflex Angle:** An angle greater than 180° and less than 360°.
   - **Complete Angle:** An angle that is exactly 360°.

2. **Pairs of Angles**
   - **Complementary Angles:** Two angles whose sum is 90°.
   - **Supplementary Angles:** Two angles whose sum is 180°.
   - **Adjacent Angles:** Two angles that have a common vertex and a common arm, but no common interior points.
   - **Vertically Opposite Angles:** A pair of opposite angles formed by the intersection of two lines. They are always equal.

Mathematical Explanation

Special Types of Angles

Angles are categorized into various types based on their degree measurements and specific properties. Let's explore the special types of angles:

1. **Acute Angle:** An angle that measures less than 90°.
   - **Example:** 30°,45°,60°.
   - **Diagram:** A small "V" shape.

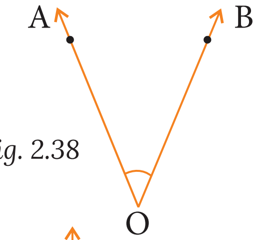


Fig. 2.38

2. **Right Angle:** An angle that measures exactly 90°.
   - **Example:** The corners of a square or rectangle.
   - **Key Feature:** It forms a perfect "L" shape.
   - **Symbol in Diagrams:** A small square is drawn at the vertex.

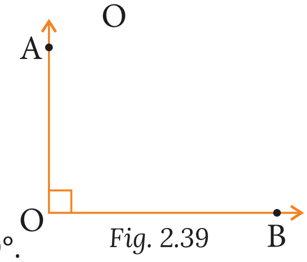


Fig. 2.39

3. **Obtuse Angle:** An angle that measures greater than 90° but less than 180°.
   - **Example:** 120°,135°,150°.
   - **Diagram:** A wide-open angle.

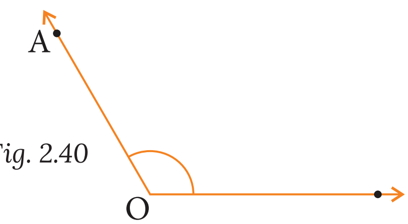


Fig. 2.40

4. **Straight Angle:** An angle that measures exactly 180°.
   - **Example:** A straight line forms a straight angle.
   - **Diagram:** A straight line.

Fig. 2.41

5. **Reflex Angle:** An angle that measures greater than 180° but less than 360°.
   - **Example:** 210°, 300°.
   - **Diagram:** A wide-open angle that looks like a "bent" circle.

Fig. 2.42

6. **Complete Angle:** An angle that measures exactly 360°.
   - **Example:** A full circle represents a complete angle.
   - **Diagram:** A full circle.

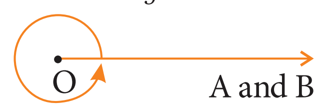


Fig. 2.43

Pair of Angles

1. **Complementary Angles:** Two angles are said to be complementary if the sum of their measures is 90°.
   - **Example:** 30° and 60° are complementary angles because 30° + 60° = 90°
   - **Key Property:** The two angles do not have to be adjacent.

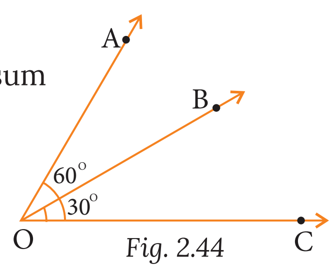


Fig. 2.44

2. **Supplementary Angles:** Two angles are said to be supplementary if the sum of their measures is 180°.
   - **Example:** 110° and 70° are supplementary because 110° + 70° = 180°.
   - **Key Property:** The two angles can form a straight line if they are adjacent.

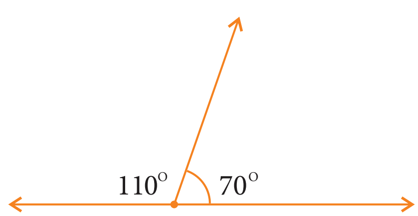


Fig. 2.45

3. **Adjacent Angles:** Two angles are called adjacent if;

i. They share a common vertex.
ii. They share a common arm.
iii. They do not overlap.

- **Examples:** The two angles formed when a ray splits another angle into two parts.

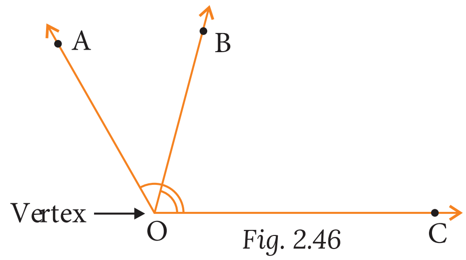


Fig. 2.46

4. **Vertically Opposite Angles:** When two lines intersect, the angles opposite to each other are called vertically opposite angles.

- **Key Property:** Vertically opposite angles are always equal.
- **Example:** If two intersecting lines form ∠A = 120°, the vertically opposite angle is also 120°.

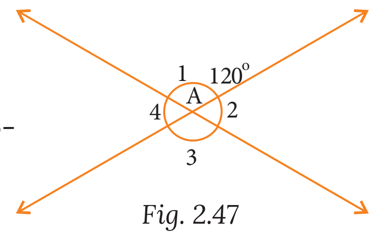


Fig. 2.47

Making Rotating Arms to Understand Angles

Rotating arms are a simple and effective way to understand how angles are formed and measured. By physically creating and observing rotating arms, students can grasp the concept of rotation and how angles increase or decrease.

Materials Needed

i. Two straight strips of cardboard or thick paper (to act as arms).
ii. A push pin or paper fastener (to act as the vertex).
iii. A protractor (to measure angles).
iv. A sheet of paper or a cardboard base.

Steps to Make Rotating Arms

1. **Prepare the Arms:**
- Cut two straight strips of cardboard or paper.
- Ensure both strips are of equal length (e.g., 15 cm each).

2. **Create the Vertex:**
- Place the two strips so that one end of each strip overlaps.
- Use a push pin or paper fastener to fix the overlapping ends together. This point will act as the vertex of the angle.

3. **Set the Base:**
- Place the rotating arms on a flat surface (like a sheet of paper or cardboard).
- Fix the vertex lightly so the arms can rotate freely.
- Fix one arm as the baseline (this will not move during the activity).

4. **Rotate the Second Arm:**

Move the second arm to different positions to form angles of varying measures.

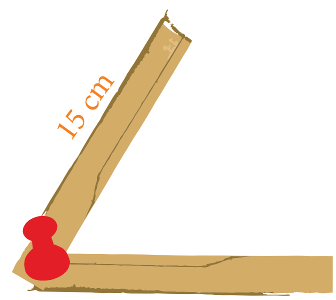


Fig. 2.48

Fig. 2.49

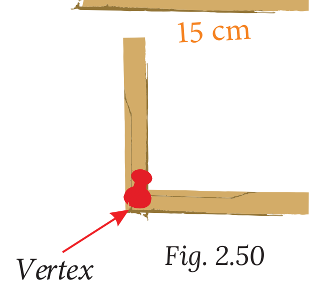


Fig. 2.50

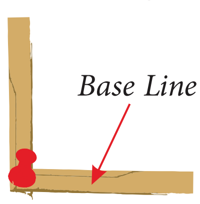


Fig. 2.51

Benefits of Rotating Arms

1. **Hands-On Learning:** Students can physically see how angles are formed.
2. **Interactive Understanding:** Rotating arms help visualize the increasing and decreasing degree of angles.
3. **Accurate Measurement:** Using a protractor with the rotating arms helps students connect theory with practice.

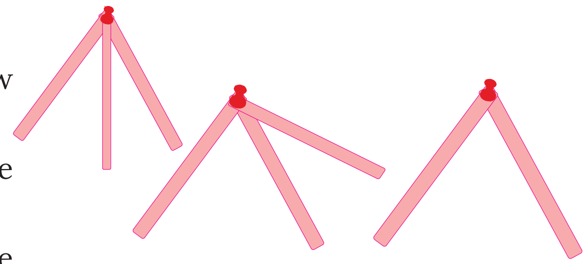


Fig. 2.52

Example 12 : How many degrees are there in:

(i) One right angle? (ii) One straight angle?
(iii) One complete angle? (iv) Two right angles?
(v) Three right angles? (vi) Four right angles?

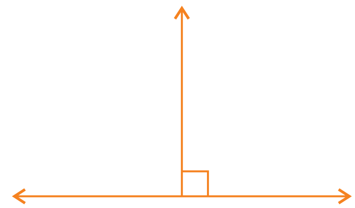


Fig. 2.53

Solution:

(i) 90° (ii) 180°
(iii) 360° (iv) 180° = 2 × 90° = 180°
(v) 270° = 3 × 90° = 270° (vi) 360° = 4 × 90° = 360°

Example 13 : Write the name of all the acute, right, obtuse, reflex, and straight angles in the given figure.

- **Angles:** ∠PQR, ∠SQP, ∠TQS, ∠TQP, ∠TQU, ∠UQV, ∠SQR, ∠SQU, ∠TQV, ∠TQR, ∠PQU, ∠PQV, ∠SQV, ∠RQV, ∠RQU

Solution: (i) **Acute Angles:** ∠PQR, ∠SQP, ∠TQS, ∠TQP, ∠TQU, ∠UQV

(ii) **Right Angles:** ∠SQR, ∠SQU, ∠TQV

(iii) **Obtuse Angles:** ∠TQR, ∠PQU, ∠PQV, ∠SQV

(iv) **Reflex Angles:** ∠RQV

(v) **Straight Angles:** ∠RQU

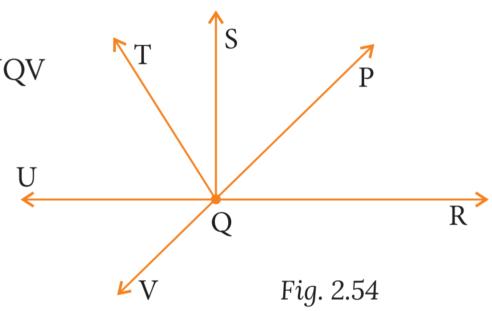


Fig. 2.54

Example 14 : From **Fig. 2.55,** write the measurement and then classify each angle:

(i) ∠MON = 30° (ii) ∠NOR = 120° (iii) ∠QOS = 90°
(iv) ∠NOS = 180° (v) ∠POR = 90° (vi) ∠NOU = 270°

Solution:

(i) Acute Angle (ii) Obtuse Angle
(iii) Right Angle (iv) Straight Angle
(v) Right Angle (vi) Reflex Angle

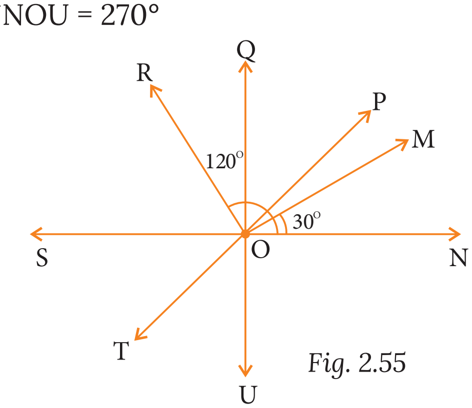


Fig. 2.55

Example 15 : Give two examples each of right, acute, and obtuse angles from your surroundings.

Solution:

- **Right Angles:** (i) Door frame, (ii) book corner
- **Acute Angles:** (i) Sharp corner of a pencil, (ii) Hands of a clock at 10:10
- **Obtuse Angles:** (i) Roof of a house, (ii) Open scissors

Drawing Angles

Drawing angles accurately is an essential skill in geometry. Using a protractor, students can draw angles of specific measures step-by-step.

Steps to Draw Angles Using a Protractor

Step 1: Draw the Base Line

Fig. 2.56

- Using a ruler, draw a straight line and label its two endpoints (e.g., A and B).
- This line will act as one arm of the angle.

Step 2: Mark the Vertex

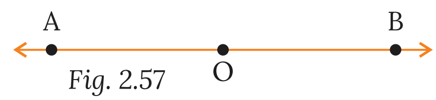


Fig. 2.57

- Place a point O on the base line. O will be the vertex of the angle.

Step 3: Place the Protractor

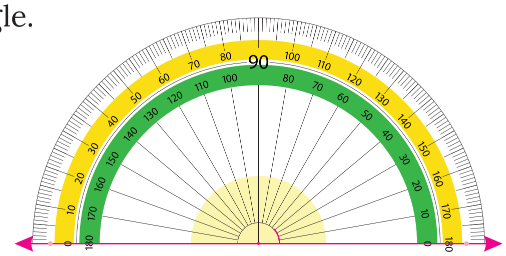


Fig. 2.58

- Align the center hole of the protractor on the vertex O.
- Align the baseline of the protractor with the base line AB.

Step 4: Mark the Angle

- Decide on the degree of the angle you want to draw (e.g., 45°,90°).
- Locate this degree on the protractor scale (inner or outer, depending on the direction and mark your angle).
- Mark the point where this degree lies (e.g., point C).

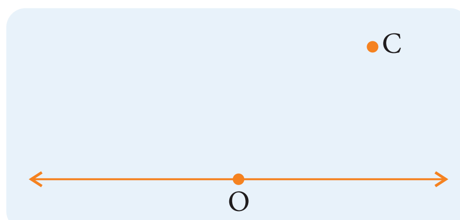


Fig. 2.59

Step 5: Draw the Second Arm

- Remove the protractor.
- Use a ruler to draw a straight line from O (the vertex) to C (the marked point).
- Label the new arm as OC.

Classify the Angle

After drawing, classify the angle based on its degree:

- **< 90° :** Acute Angle.
- **= 90°:** Right Angle.
- **90° < Angle < 180°:** Obtuse Angle.
- **= 180°:** Straight Angle.

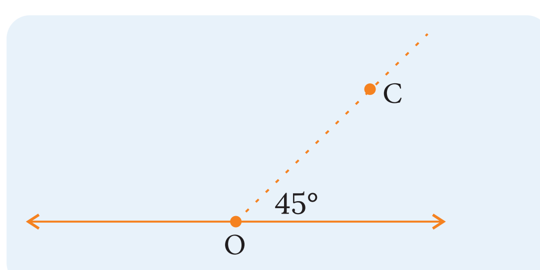


Fig. 2.60

Activity Time: Make Your Own Protractor!

Creating your own protractor is a fun and educational activity that helps you understand how angles and degrees work. Let's build a simple protractor using everyday materials.

Materials Needed

i. A piece of cardboard or thick paper.
ii. A compass (for drawing a circle).
iii. A ruler.
iv. A pencil.
v. A marker or pen.
vi. A pair of scissors.
vii. A small pin (optional, for the center point).

Steps to Make Your Own Protractor

Step 1: Draw a Semi-Circle

i. Take the cardboard or thick paper.
ii. Use the compass to draw a semi-circle with a radius of about 10 cm.
iii. Label the center point of the semi-circle as O.

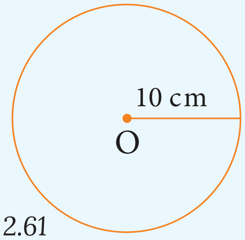


Fig. 2.61

Step 2: Draw the Baseline

i. Use the ruler to draw a straight horizontal line through the center of the semi-circle.
ii. This line is the baseline, and it divides the semi-circle into two equal halves.

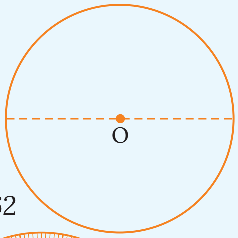


Fig. 2.62

Step 3: Mark the Degrees

i. On the curved edge of the semi-circle, divide it into equal parts:
   - Start at the far left (labeled as 0°).
   - Mark the far right as 180°.
ii. Using the ruler and pencil, divide the curve into smaller intervals: 0°, 10°, 20°,..., 180°.
iii. Add additional markers for smaller intervals (e.g., 5°) if you want more precision.

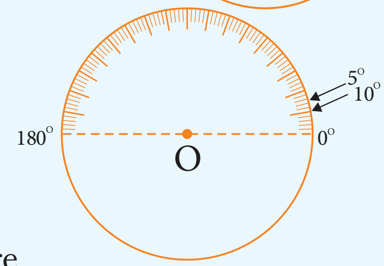


Fig. 2.63

Step 4: Add Lines for Angle Measurements

i. From the center O, draw straight lines to each marked degree on the semi-circle.
ii. These lines represent the arms of different angles (e.g., 30°, 60°, 90°,...).

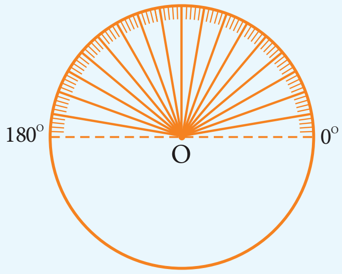


Fig. 2.64

Step 5: Label the Protractor

i. Write the degree values along the curved edge:0°, 10°, 20°,...,180°.
ii. Highlight key angles like 90° and 180° with a marker for easy identification.

Step 6: Cut It Out

i. Carefully cut along the curved edge of the semi-circle.
ii. Ensure the protractor is smooth and easy to handle.

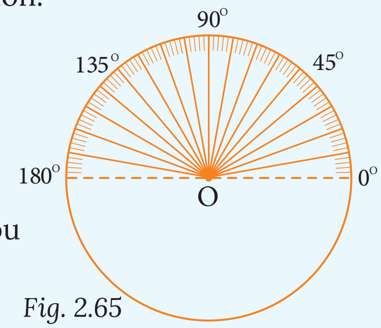


Fig. 2.65

How to Use Your Protractor

1. Place the center point of your protractor on the vertex of the angle you want to measure.
2. Align the baseline with one arm of the angle.
3. Read the degree measurement where the second arm of the angle intersects the curved edge.

Starfish arms (5 arms)
When joined at the center, they form 5 equal central angles of 72° each (72, 144, 216, 288, 360).

Spider webs
threads divide the circle into equal angles — e.g., 6 spokes form 60° angles, 8 spokes form 45° angles.

Honeycomb cells
each corner is a 120° angle; repeating gives a constant angle pattern.

Sun rays at sunrise
Often drawn as straight lines meeting at a point → angles around a point add to 360°.

Leaves in a whorl
3 leaves around a stem divide the circle into 120°, 120°, 120° —a repeating angle pattern.

Pineapple pattern
The criss-cross lines on the skin make acute and obtuse angles where they meet.

Knowledge Checkpoint

- What is the complement of a 75° angle?
- What is the supplement of a 100° angle?
- If two lines intersect and one angle is 80°, what is its vertically opposite angle?

Activity

Paper Folding Angles

Objective: To create and identify different types of angles by folding paper.

Materials: A circular piece of paper (coffee filter works well), a rectangular piece of paper.

Procedure:

1. **Right Angle:** Take the rectangular paper. Fold any edge onto itself. The crease you make is a straight line. Now fold the paper so the crease lies on top of itself. Unfold. The two creases form four perfect right angles.
2. **Acute/Obtuse:** Fold the right angle you just made in half. The new angle is 45° (acute). Unfold and fold it in another way to create an obtuse angle.
3. **Supplementary:** Take the circular paper. Fold it exactly in half. The crease is a diameter and represents a straight angle (180°). Make another fold from the center to any point on the edge. You have now created two adjacent angles that are supplementary.

Key Terms

- **Acute Angle:** An angle measuring less than 90°.
- **Right Angle:** An angle measuring exactly 90°.
- **Obtuse Angle:** An angle measuring between 90° and 180°.
- **Straight Angle:** An angle measuring exactly 180°.
- **Reflex Angle:** An angle measuring between 180° and 360°.
- **Complementary Angles:** Two angles whose measures sum to 90°.
- **Supplementary Angles:** Two angles whose measures sum to 180°.
- **Adjacent Angles:** Angles that share a common vertex and a common side.
- **Vertically Opposite Angles:** The angles opposite each other when two lines cross.

Facts Flash

The sum of the angles in any triangle is always 180° (a straight angle). The sum of the angles in any quadrilateral is always 360° (a complete angle). This is a fundamental rule in geometry!

Do It Yourself

Imagine a clock face. At what times (other than 3:00 and 9:00) do the hour and minute hands form a perfect right angle (90°)? It's trickier than you think because the hour hand is also moving! There are two such times between every hour.

Mental Mathematics

- I am an acute angle. My complement is also an acute angle. What could I be? (Any angle between 1° and 89°).
- I am an obtuse angle. What type of angle is my supplement? (Acute).
- Two angles form a linear pair (are supplementary and adjacent). One is 50°. The other is? (130°).
- What is the reflex angle to a right angle? (360° - 90° = 270°).
- Find the angle that is double its complement. (Let the angle be x. Then x = 2(90-x). x = 180 - 2x. 3x = 180. x = 60°).

Gap Analyzer™ Homework

Watch Remedial

Exercise 2.4

1. Provide the missing information in the blanks:

a) An angle less than 90° is called an _______ angle.

b) A _______ angle measures exactly 90°.

c) A _______ angle measures greater than 90° but less than 180°.

d) The angle formed when the arms are perpendicular is called a _______ angle.

e) A straight line formed by the arms represents a _______ angle.

2. **Identify the Type of Angle:**

a) 60°	b) 150°	c) 90°	d) 270°	e) 45°
f) 230°	g) 120°	h) 170°	i) 220°	j) 280°

3. While sitting in the park, Ayaan noticed two benches placed at a right angle to each other.
   - He saw the branches of a bush forming sharp angles where they met.
   - Above him, a butterfly opened its wings wide, creating a broad angle between them.

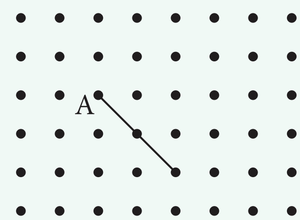
   Questions:

   i. What type of angle is formed between the two benches?
   ii. What type of angle do the bush branches likely form?
   iii. Which object shows an obtuse angle in the statement?
   iv. Name the angle pair formed if the benches were extended in a straight line.

4. **Illustration shows a child flying a kite with the string and its shadow making a continuous straight line.**

5. **In Fig., draw straight lines from A to other grid points to form:**

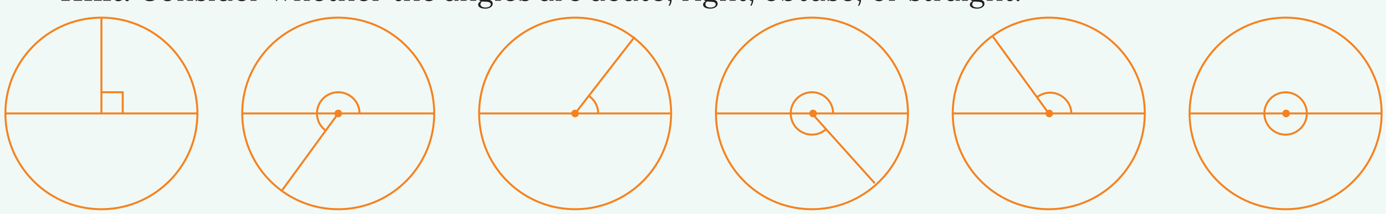
   

   a) An acute angle.
   b) An obtuse angle.
   c) A reflex angle.

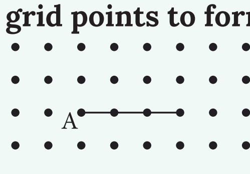
   Task: List and label all possible ways to achieve these angles.

6. **Observe the angles in the given diagram. Estimate the measure of each angle with your eyes, then use a protractor to measure and verify your estimate.**

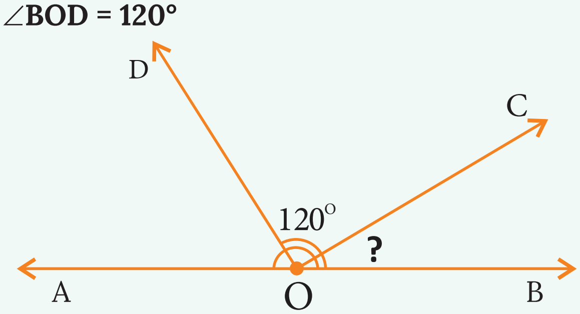
   Hint: Consider whether the angles are acute, right, obtuse, or straight.



7. **In a similar grid diagram, join A to other grid points to form:**
   a) A complementary pair of angles.
   b) A supplementary pair of angles.

8. **In the given figure, ∠BOC is part of ∠AOB, which is a straight line. If ∠AOB=180°, find the measure of ∠BOC when ∠BOD = 120°**



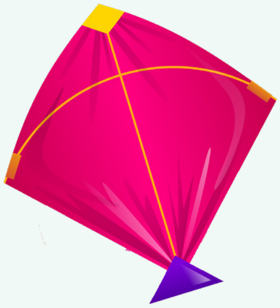
9. You are building a kite! The shape of the kite depends on the angle at which the two wooden spars (sticks) cross.

   Task:

   i. Draw a vertical line 15 cm long. This is your main spar.

   ii. Mark a point 5 cm from the top of this line.

   iii. Draw a horizontal line (the cross spar) 10 cm long that passes through this point, creating a 90° angle. Connect the four ends to see your kite.

   Challenge: On another drawing, what happens if the cross spar intersects the main spar at an 80° angle? Draw it and compare the shapes.

10. **You are drawing a map for a friend showing how to get to the library.**

    Task:

    i. Draw a horizontal line across your page and label it "Main Street."

    ii. Draw another straight line and label it "Park Avenue" so that it intersects Main Street at a 65° angle.

    iii. The library is on a corner formed by this intersection. Draw a small square to represent the library.

    iv. Using your knowledge of supplementary and vertically opposite angles, calculate and label the other three angles at the intersection without measuring them. Then, use your protractor to check your work!

11. You are in charge of slicing a pizza for a party. To be fair, everyone must get an equal slice. The whole pizza is a complete angle (360°).

    Task:

    i. First, calculate the angle for one slice if the pizza is to be cut into 8 equal slices. (**Hint:** 360° ÷ 8 = ?)

    ii. Draw a point on your paper to be the center of the pizza.

    iii. Draw a line segment from the center to the edge (this is your first cut).

    iv. Using your protractor, measure and draw the second cut to create a perfect 45° slice.

Common Misconceptions

Misconception: The size of an angle depends on how long its arms are drawn.

Correction: The measure of an angle is about the "opening" or "turn" between the rays, not their length. Rays extend infinitely anyway! An angle of 45° is the same size whether its arms are drawn 2 cm long or 20 cm long on the page.

Misconception: Complementary and supplementary angles must be adjacent (next to each other).

Correction: While they can be adjacent, they don't have to be. A 30° angle in one corner of the room and a 60° angle in the opposite corner are still complementary because their sum is 90°. The relationship is based on their sum, not their position.

Misconception: When naming an angle like ∠ABC, the order of the letters doesn't matter.

Correction: The middle letter is CRITICAL! It must always be the vertex. ∠ABC and ∠CBA are the same angle, but ∠BAC would be a completely different angle with its vertex at A.

Real-Life lines and Angles: Mathematical Applications

- **The Clock Face:** The hands of a clock are a perfect, dynamic example. At 3:00, they form a right angle (90°). At 1:00, they create an acute angle, and at 5:00, an obtuse angle, making time-telling a live geometry lesson.
- **Architectural Features:** The corner of their room or a textbook demonstrates perpendicular lines creating a right angle. Shelves in a bookcase or the opposite sides of a window frame are excellent examples of parallel lines.
- **Navigation & Roads:** A simple crossroad shows intersecting lines. A "Y" junction on a road forms acute angles, while a direct right turn is a 90° angle. This connects geometry to everyday movement and maps.
- **Playground Fun:** A slide forms an acute angle with the ground. The bars on a jungle gym often showcase parallel and perpendicular lines. Even the angle of a see-saw changes as it moves up and down.

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. A straight angle measures:
   (a) 90° ☐ (b) 180° ☐ (c) 360° ☐ (d) 0° ☐
2. Two angles whose sum is 90° are called:
   (a) Complementary angles ☐ (b) Supplementary angles ☐
   (c) Adjacent angles ☐ (d) Reflex angles ☐
3. How many right angles are there in a complete angle?
   (a) 1 ☐ (b) 2 ☐ (c) 3 ☐ (d) 4 ☐
4. If one angle is 70°, its complement is:
   (a) 110° ☐ (b) 90° ☐ (c) 20° ☐ (d) 50° ☐
5. In a pair of supplementary angles, one angle is 110°. The other angle is:
   (a) 60° ☐ (b) 70° ☐ (c) 50° ☐ (d) 90° ☐

Assertion & Reason

In each of the following questions, an Assertion (A) and a corresponding Reason (R) supporting it is given. Study both the statements and state which of the following is correct:

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false. d) A is false but R is true.

1. **Assertion:** The sum of complementary angles is always 90°.
   Reason: Complementary angles are always adjacent.
2. **Assertion:** A straight line forms an angle of 180°.
   Reason: A straight angle is the sum of two right angles.
3. **Assertion:** A pair of vertically opposite angles are always equal.
   Reason: Vertically opposite angles are formed when two lines intersect.

Case Study

The Park Designer

An architect is designing a new community park. The plan shows a straight path (Path A) running from East to West. Another straight path (Path B) intersects it, creating a 70° angle on the northeast corner.

1. What are the measures of the other three angles at this intersection?
2. The architect wants to add a third path (Path C) that is perfectly parallel to Path A. Draw this on a diagram.
3. If Path B also intersects Path C, what will be the measures of the angles formed at that new intersection? Explain your reasoning.

Project

My Dream Room Blueprint

Objective: To apply all the concepts from the chapter to a practical design project.

Task: You are an interior designer, and your client (you!) wants a blueprint for their dream room. On a large sheet of paper, you must design the layout of this room.

Requirements:

1. The room must be a polygon (e.g., a rectangle, or an L-shape for a challenge).
2. Use a ruler to draw the walls to scale (e.g., 1 cm on paper = 20 cm in real life).
3. Parallel & Perpendicular Lines: The opposite walls of any rectangular section must be parallel. Adjacent walls must be perpendicular (form 90° angles).
4. **Furniture:** Draw at least four pieces of furniture (bed, desk, shelf, rug).
   - The desk must be placed at a specific angle to the wall (e.g., 45°). Measure and label this angle.
   - A rug on the floor must have its edges parallel to the walls.
5. **Decoration:** Design a pattern on one wall or on the rug that uses intersecting lines. Label a pair of vertically opposite angles and a pair of supplementary angles in your pattern.
6. **Labeling:** Clearly label all the geometric elements: parallel lines, right angles, your chosen acute/obtuse angles, and the angle pairs.

- **Presentation:** Present your blueprint to the class, explaining how you used the principles of lines and angles to create a well-designed and functional room.

Source-Based Question

Based on Govt. Data + Geometry Context

Directions: According to the Ministry of Road Transport & Highways Annual Report 2023, several national highway projects were completed in 2022–23, improving road connectivity at major intersections.

At the NH-44 and NH-48 intersection in Delhi:

- Engineers measured the acute angle between NH-44 (North–South) and NH-48 (North-East to South-West) as 65°.
- The obtuse angle on the opposite side measured 115°.
- A proposed service road will be built parallel to NH-48, 200 meters away, to reduce congestion.
- A pedestrian path will cross NH-44 at a right angle.

(Source: Adapted from MoRTH Annual Report 2023)

Questions:

1. What type of angles are 65° and 115° in geometric terms?
2. What is the relationship between the 65° angle and the 115° angle at the NH-44/NH-48 intersection?
3. The pedestrian path is perpendicular to NH-44. What angle does it make with NH-44?
4. If the service road is parallel to NH-48, what is the measure of the angle it will form with NH-44?
5. Which pair of angles at the NH-44/NH-48 intersection are vertically opposite?

Source Text (Adapted from Survey of India & Smart City Mission Data)

As part of the Smart City Mission 2024, the Survey of India mapped a new central square in Bhopal where four main roads meet:

- Road X runs East–West.
- Road Y runs North–South and crosses Road X at the central square.
- The crossing forms four right angles.
- A new Cycle Lane Z leaves Road X heading 60° north-east.
- A Pedestrian Walkway W is planned parallel to Road X, 80 m south of it.

(Source: Adapted from Survey of India Urban Plan Report, 2024)

Questions:

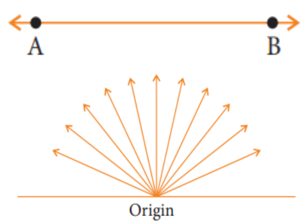
1. At the intersection of Road X and Road Y, what is the measure of each angle?
2. Classify the angle between Cycle Lane Z and Road X.
3. If Cycle Lane Z makes a 60° angle with Road X, what is the measure of its supplementary angle?
4. What is the relationship between Road X and Pedestrian Walkway W?
5. Which pair of angles at the central square are vertically opposite?

Mind Map

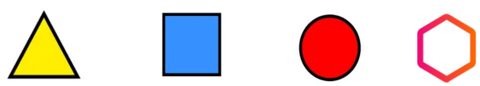
Lines and Angles

Basic Geometrical Figures

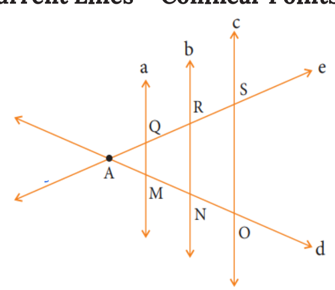
- Point • Line • Line Segment • Ray



- Triangle • Quadrilaterals • Circle • Polygons



- Parallel Lines • Intersecting Lines
- Concurrent Lines • Collinear Points



Curves

❖ **Open Curve** → Has two ends (like a wavy line).

❖ **Closed Curve** → Forms a loop (like a circle).

❖ **Simple Curve** → Does not cross itself.

❖ **Non-Simple Curve** → Crosses itself (like figure 8).

❖ **Plane Curve** → Lies flat on paper (circle, ellipse).

❖ **Space Curve** → Goes in 3D (helix, spiral).

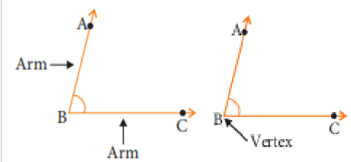
Angles

❖ **Vertex** → Common meeting point of two rays.

❖ **Arms** → The two rays that form the angle.

❖ **Measure in Degrees (°) using Protractor.**

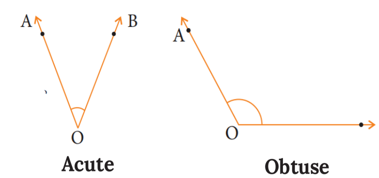
❖ **Examples:** Corner of a book, clock hands, open door.



Types of Angles & Angle Pairs

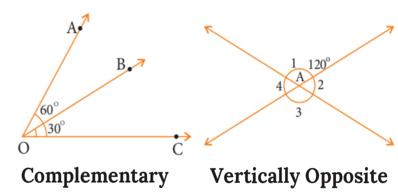
❖ **Types of Angles:**

✓ Acute (<90°), Right (90°), Obtuse (90°–180°), Straight (180°), Reflex (180°–360°), Complete (360°).



❖ **Angle Pairs:**

✓ Complementary (90°), Supplementary (180°), Adjacent (side-by-side), Vertically Opposite (equal when lines cross).



Drawing Angles

❖ Use a protractor to draw angles like 45°, 90°, 135°.

❖ **Classify:** Acute (<90°), Right (=90°), Obtuse (90°–180°), Straight (=180°).