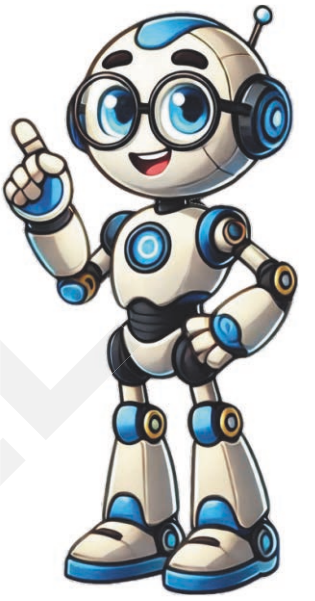
2
Chapter

Lines and Angles

We'll cover the following key points:

- → Introduction to Lines and Angles
- → Basic Geometrical Figures
- → Curves
- → Introduction to Angles
- → Measuring an Angle
- → Degree Measure of an Angle
- → Comparison of Angles
- → Making Rotating Arms to Understand Angles
- → Special Types of Angles
- → Drawing Angles



Hi, I'm EeeBee

Do you Remember fundamental concept in previous class.

In class 5th we learnt

- → Measuring and Drawing an Angle
- → Lines and Angles

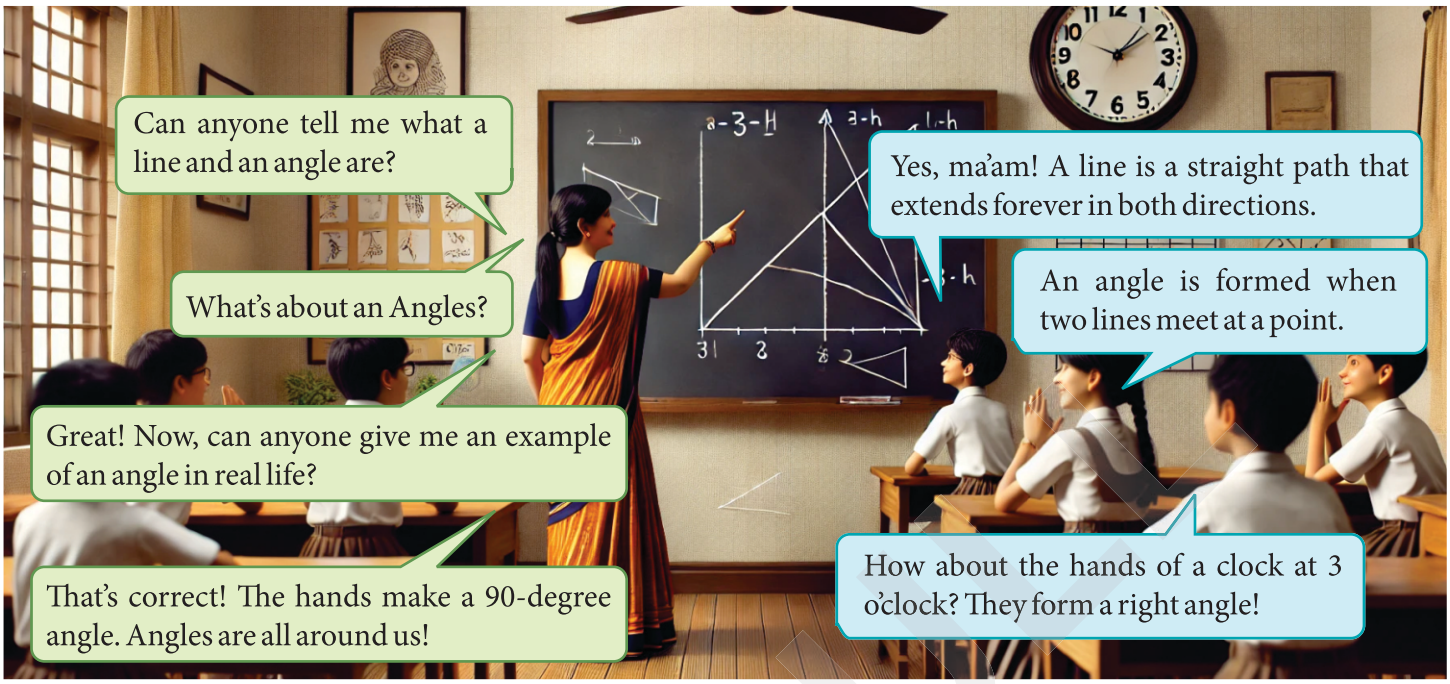
Still curious? Talk to me by scanning the QR code.

Learning Outcomes

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

- Identify and define types of lines (parallel, perpendicular, intersecting) and angles (acute, right, obtuse).
- Measure angles using a protractor.
- Understand and apply properties of angles on a straight line and around a point.
- Use the concept of complementary and supplementary angles.
- Explore the relationship between angles formed by parallel lines and transversals.
- Identify and classify different types of triangles based on their angles.
- Understand and solve problems involving the properties of lines and angles.
- Create and analyze geometric figures involving lines and angles.
- Investigate vertical, alternate interior, and corresponding angles formed by intersecting lines and transversals.
- Construct accurate bisectors of angles and perpendicular bisectors of segments using traditional geometric tools.

Introduction



Take a Task Watch Remedial

Lines and angles are fundamental concepts in geometry, helping us understand the relationships between different shapes and structures

1. **Lines:** A line is a straight one-dimensional figure with no thickness, extending infinitely in both directions. It is defined by two points, such as AB, where A and B are points on the line. A line segment is part of a line with two defined endpoints.

2. **Angles:** An angle is formed when two rays (or line segments) share a common endpoint, known as the **vertex**. The measure of the angle is the space between the two rays, usually expressed in degrees. Common types of angles include:

   - **Acute Angle:** Less than 90°
   - **Right Angle:** Exactly 90°
   - **Obtuse Angle:** Greater than 90° but less than 180°
   - **Straight Angle:** Exactly 180°

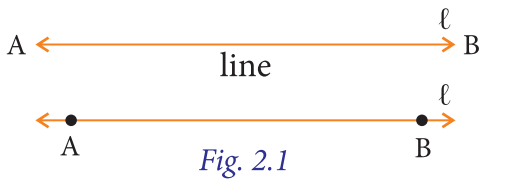


Fig. 2.1

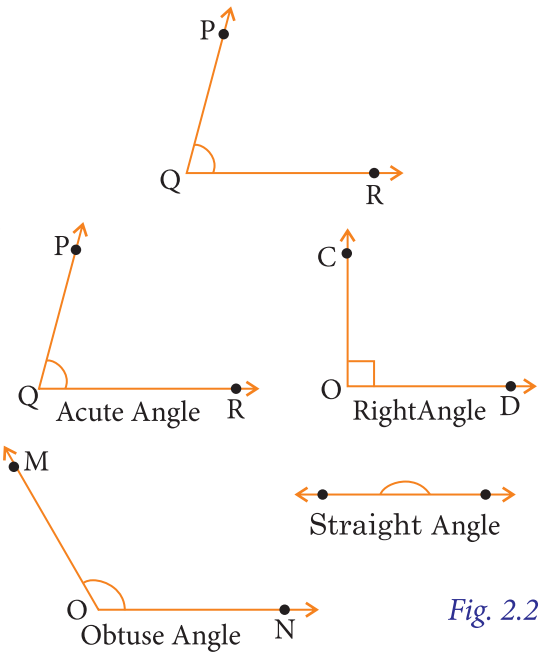


Fig. 2.2

Basic Geometrical Figures:

Students typically learn about the fundamental geometric shapes and figures that form the foundation of geometry. Here are the essential figures that are introduced at this level:

1. 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. 2.3

2. 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. 2.4

3. Line Segment:

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

Fig. 2.5

4. 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.

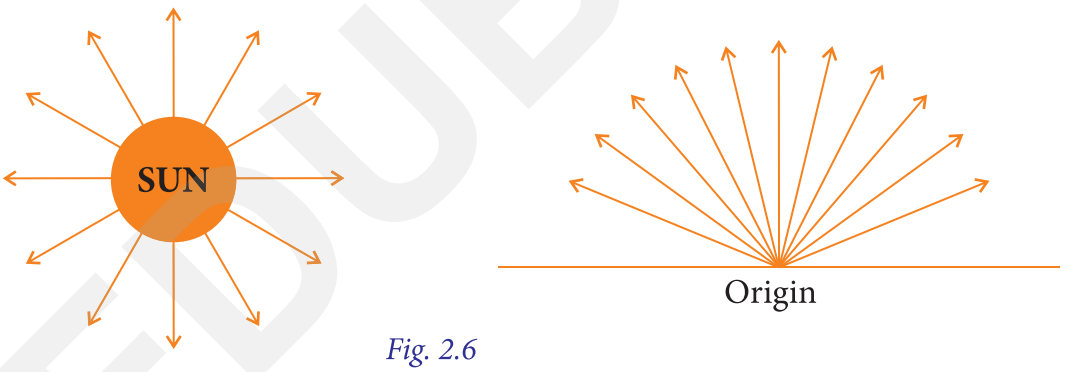


Fig. 2.6

5. 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.

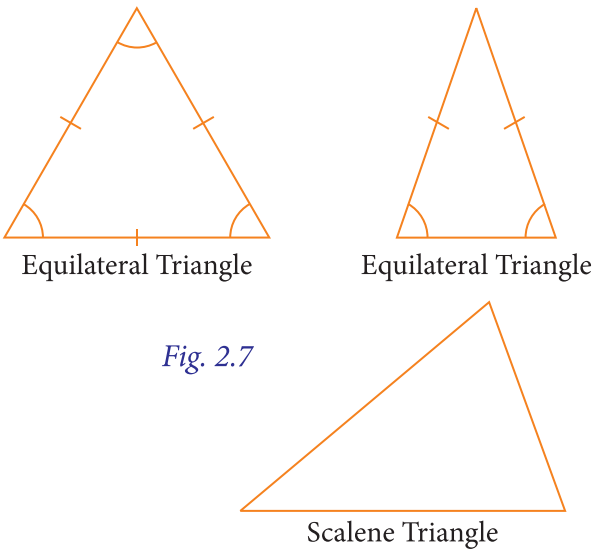


Fig. 2.7

6. 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. 2.8

7. 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**.

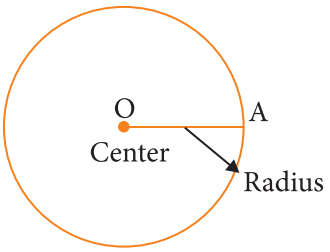


Fig. 2.9

8. Polygons:

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

- **Pentagon:** 5 sides
- **Hexagon:** 6 sides
- **Heptagon:** 7 sides
- **Octagon:** 8 sides

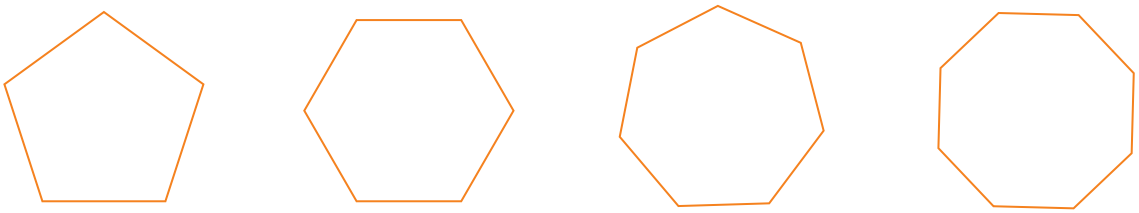
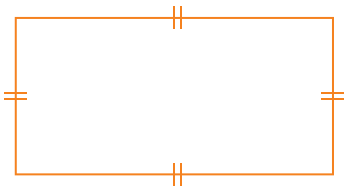


Fig. 2.10

9. 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**.



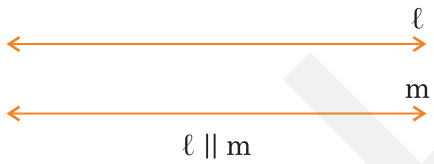


Fig. 2.11

10. 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.

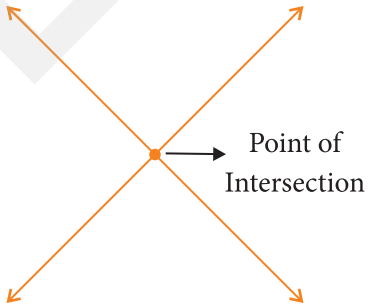


Fig. 2.12

11. 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.

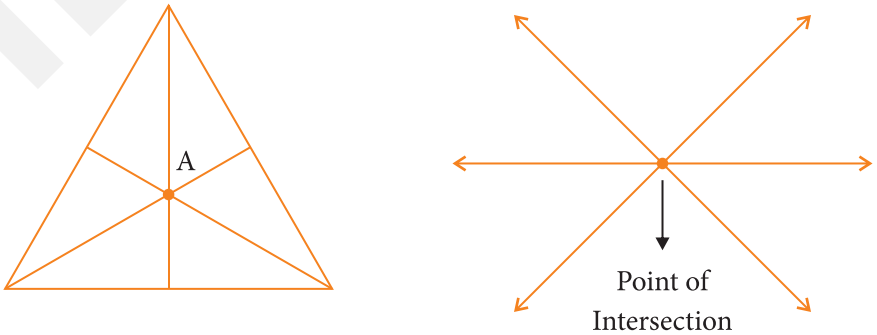


Fig. 2.13

12. 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 (ii) Non-Collinear point

Fig. 2.14

Example : Use Fig 2.15 to name:

(i) Six points (ii) a line (iii) Four rays (iv) five line segments

(v) Two rays with initial point C

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) PC, QC

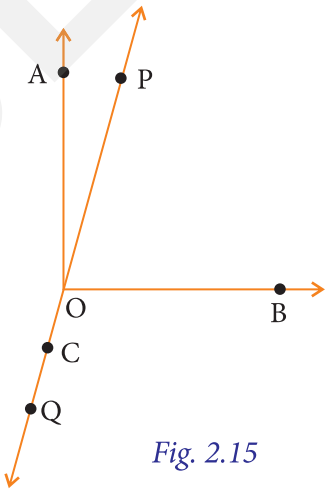


Fig. 2.15

Example : Observe Fig. 2.16 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. 2.16

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) Rays AB and BA are the same because they have the same initial point and extend endlessly in the same direction.

(iii) Rays BC and CB are different because they extend endlessly in opposite directions even though they have the same initial point.

Example : From the adjoining figure 2.17, 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.

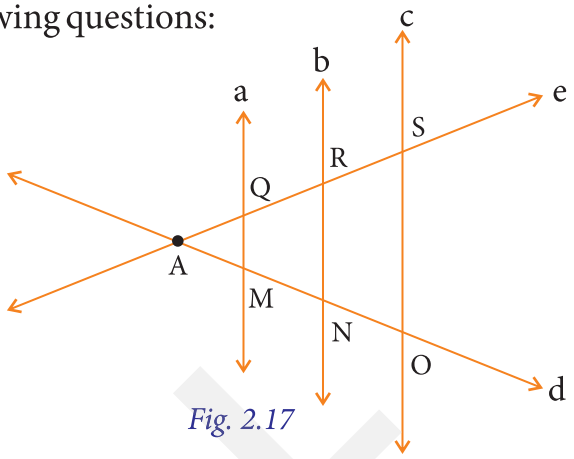


Fig. 2.17

Solution:

(i) Lines a and b, lines c and b and lines a and c are parallel.

(ii) Lines a and e, lines b and e, lines c and e, lines d and e, lines a and d, and lines b and c and lines c and d are intersecting.

(iii) Lines a and e intersect at Q.

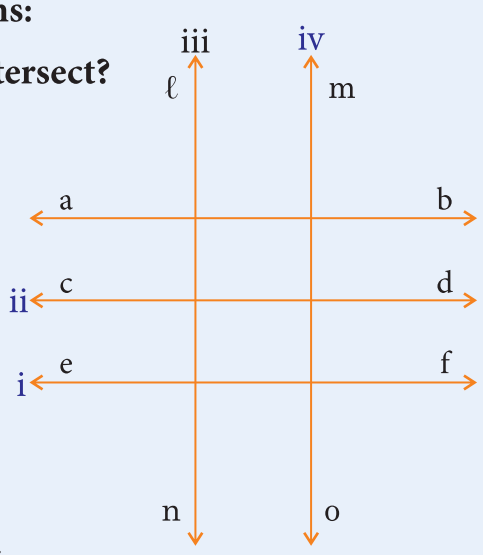
(iv) Lines c and d contain point O.

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

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. How many lines can pass through?

(a) One given point? (b) Two distinct points? (c) Three Collinear Points

3. **Draw a rough figure and label suitably for each of the following cases:**

(a) Point A lies on line XY.

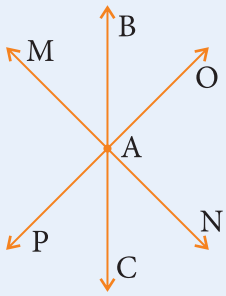
(b) $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at point O.

(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.

4. **Identify relationships in the diagram (provide a figure):**



(a) Name the point of intersection of two lines.

(b) Identify all collinear points.

(c) Determine if given points lie on the same line.

5. **Mark four points X, Y, Z, and W on a page of a notebook such that no three of them are collinear. Draw lines through these points taking two at a time.**

(a) How many different lines did you obtain?

(b) Write the name of these lines.

(c) Write the name of lines which are concurrent at X.

6. **Mark three non-collinear points P, Q, and R on a page of a notebook. Draw lines through these points taking two at a time.**

(a) How many different lines did you obtain?

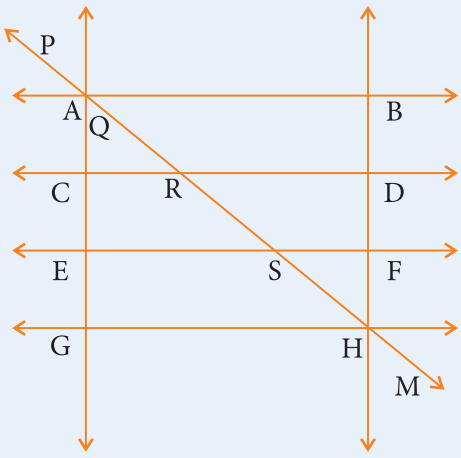
(b) Write the name of these lines.

(c) Write the name of lines which intersect at P.

7. **Match the following column;**

Column A	**Column B**
i. Line	a. Extends infinitely in one direction
ii. Ray	b. Opposite sides are parallel
iii. Parallel Lines	c. Lines that meet at 90°
iv. Perpendicular Lines	d. A line that intersects two parallel lines
v. Transversal	e. Extends infinitely in both directions

8. **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.

Curves

A curve is a continuous and smooth flowing line without any sharp angles. Curves can be open or closed and are widely used in geometry, art, and design.

Take a Task Watch Remedial

Types of Curves

1. Open Curve:

- An open curve does not form a closed shape.

Example: A wavy line or an arc.

Fig. 2.18

2. Closed Curve:

- A closed curve forms a complete, enclosed shape.

Example: A circle or an oval.

Fig. 2.19

3. Simple Curve:

- A curve that does not cross itself.

Example: A semicircle or a smooth "U"-shaped line.


Fig. 2.20

4. Non-Simple Curve:

- A curve that crosses itself at one or more points.

Example: A figure-eight or a loop.


Fig. 2.21

5. Plane Curve:

- A curve that lies completely on a flat surface (plane).

Example: A circle, parabola, or ellipse.

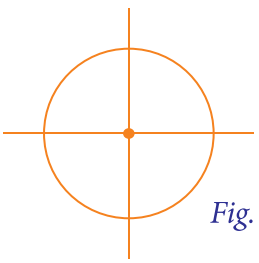


Fig. 2.22

6. Space Curve:

- A curve that extends into three-dimensional space.

Example: A helix or spiral.


Fig. 2.23

Example : 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. 2.24

Exercise 2.2

1. Provide the missing information in the blanks:

(a) A _____ is a continuous and smooth flowing line without sharp angles.

(b) A curve that forms a complete enclosed shape is called a _____ curve.

(c) A _____ curve does not cross itself.

(d) A _____ curve crosses itself at one or more points.

(e) A circle is an example of a _____ curve.

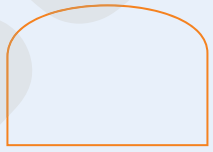
2. Does the following statement stand True (T) or False (F):

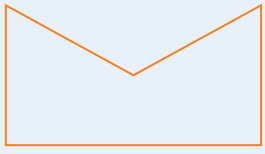
(a) An open curve can form a closed shape. (b) A simple curve does not cross itself.

(c) All closed curves are made of straight lines. (d) A curve can be drawn on a flat surface.

(e) A figure-eight is an example of a non-simple curve.

3. Identify the following curves as open or closed.

(a)  (b)  (c)  (d) 

(e)  (f)  (g)  (h) 

4. Multiple Choice Questions (MCQs):

(a) Which of the following is an example of a closed curve?

(i) A line (ii) A semicircle

(iii) A circle (iv) None of these

(b) A curve that does not form a closed shape is called:

(i) Open Curve (ii) Closed Curve

(iii) Simple Curve (iv) None of these

(c) A curve that crosses itself is called:

(i) Simple Curve (ii) Non-Simple Curve

(iii) Plane Curve (iv) None of these

5. **Short Answer Questions:**

(a) What is the difference between an open curve and a closed curve?

(b) Give two examples of a simple curve.

(c) Draw a diagram of a closed curve made up of both straight lines and curved parts.

(d) What do you call a curve that lies completely on a flat surface?

(e) Is a figure-eight a simple curve or a non-simple curve? Explain.

6. **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.

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.

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.**, which form angles between them as and when their hands open.

Fig. 2.25

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.

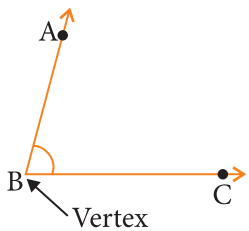


Fig. 2.26

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.

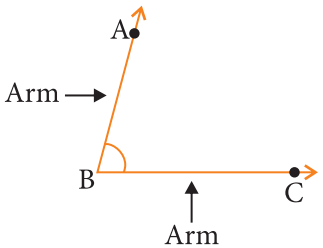


Fig. 2.27

3. Angle:

- The space or turning effect between the two arms is the angle.

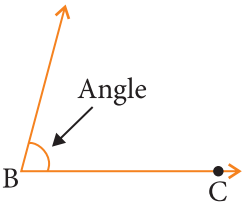


Fig. 2.28

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.


(i)


(ii)


(iii)


(iv)

Fig. 2.29

Notation for an Angle

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

1. 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:

- If A, B, and C are points, where B is the vertex, the angle is written as: $\angle ABC$ or $\angle CBA$
- In this notation, B is the vertex.
- AB and BC are arms.

Points to Remember

- Always place the vertex in the middle when naming angles using three points.
- Diagrams often use numbers for clarity when multiple angles share the same vertex.

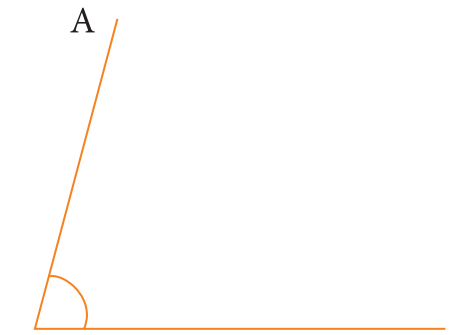


Fig. 2.30

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.

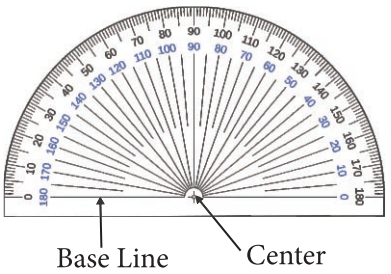


Fig. 2.31

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.

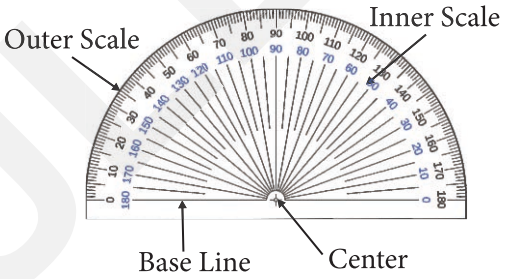


Fig. 2.32

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.

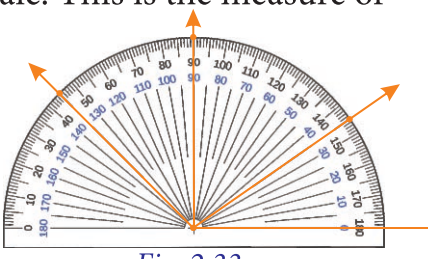


Fig. 2.33

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.

Points to Remember

1. The unit of angle measurement is degrees (°).
2. Always use the correct scale of the protractor.
3. Align the protractor accurately with the vertex and one arm of the angle.

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).

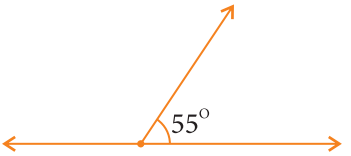


Fig. 2.34

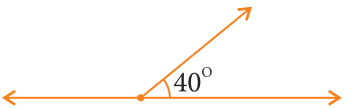


Fig. 2.35

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.

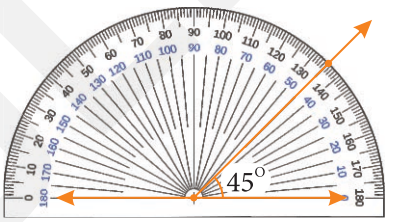


Fig. 2.36

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 :

- 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 :

- 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 : How many angles are in the given Fig.? Name them.

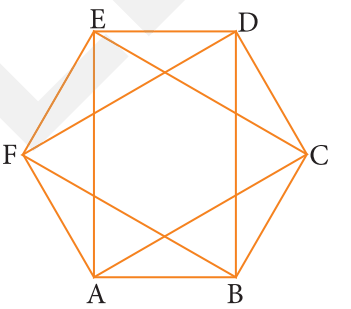


Fig. 2.37

Solution:

There are six angles, and their names are:

(i) $\angle ABC$ (ii) $\angle BCD$

(iii) $\angle CDE$ (iv) $\angle DEF$

(v) $\angle EFA$ (vi) $\angle FAB$

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

(i) $\angle 1$ (ii) $\angle 2$

(iii) $\angle 3$ (iv) $\angle 4$

(v) $\angle 5$ (vi) $\angle 6$

(vii) $\angle 7$ (viii) $\angle 8$

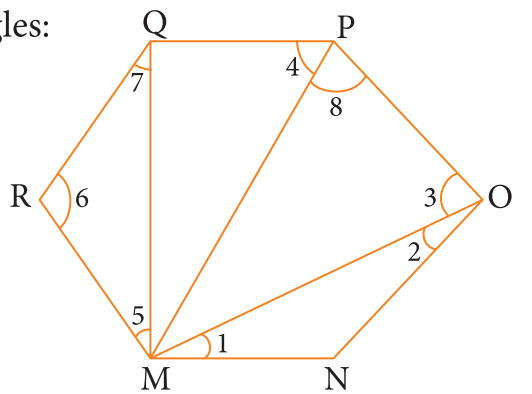


Fig. 2.38

Solution:

(i) $\angle 1 = \angle NMO$ or $\angle OMN$ (ii) $\angle 2 = \angle MON$ or $\angle NOM$

(iii) $\angle 3 = \angle MOP$ or $\angle POM$ (iv) $\angle 4 = \angle MPQ$ or $\angle QPM$

(v) $\angle 5 = \angle RMQ$ or $\angle QMR$ (vi) $\angle 6 = \angle MRQ$ or $\angle QRM$

(vii) $\angle 7 = \angle RQM$ or $\angle MQR$ (viii) $\angle 8 = \angle MPO$ or $\angle OPM$

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

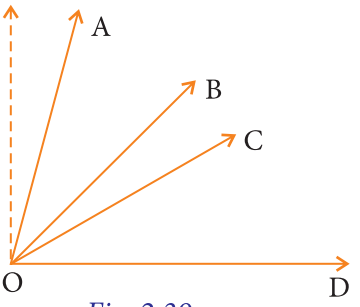


Fig. 2.39

In the fig., 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.

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

By observing the fig., we can say ∠XOA is greater than ∠AOB.

Also, ∠XOA + ∠AOY = ∠XOY

and ∠BOY + ∠AOY = ∠AOB

Clearly, when we add the same ∠AOY to both ∠XOA and ∠BOY, we get ∠XOY is greater than ∠AOB.

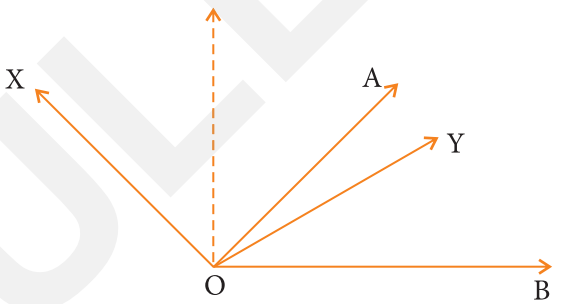


Fig. 2.40

Activity Time

Angle Hunt in the Classroom

Objective: Identify different types of angles in the surroundings.

Materials Needed: Notebook, pen/pencil.

Instructions:

- Ask students to observe their surroundings (windows, doors, walls, clock hands, etc.).
- They need to identify right angles (90°), acute angles (<90°), and obtuse angles (>90°).
- They will list the objects and the type of angles they found in a table.
- Discuss their findings as a class.

Points to Remember on Lines and Angles

Rotation can be clockwise (right) or counterclockwise (left).

A full rotation forms a 360° complete angle.

Align the baseline of the protractor with one arm of the angle.

Bigger opening → Larger angle.

A straight angle (180°) is always larger than a right angle (90°).

A reflex angle is greater than 180° but less than 360°.

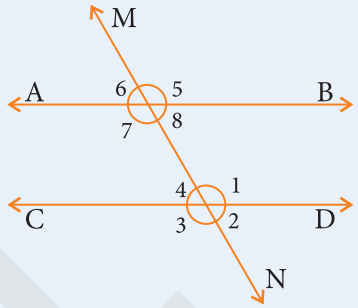
If two angles add up to 90°, they are complementary.

If two angles add up to 180°, they are supplementary.

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) $\angle 1$ (b) $\angle 2$ (c) $\angle 3$

(d) $\angle 4$ (e) $\angle 5$ (f) $\angle 6$

(g) $\angle 7$ (h) $\angle 8$

3. Provide the missing information in the blanks:

(a) An angle is formed when two _____ meet at a common point.

(b) The common point where two rays meet is called the _____ of the angle.

(c) A right angle measures exactly _____ degrees.

(d) An angle greater than 90° but less than 180° is called an _____ angle.

(e) A straight angle measures _____ degrees.

4. Does the following statement stand True (T) or False (F):

(a) A reflex angle is less than 90°

(b) A straight angle measures 180°

(c) Two rays meeting at a point always form a right angle.

(d) A complete angle measures 360°

(e) An obtuse angle is greater than 180°.

5. Short Answer Questions

(a) What is the difference between an acute angle and an obtuse angle?

(b) Name the instrument used to measure angles.

(c) If one angle of a right triangle is 30°, what is the measure of the other acute angle?

(d) Draw a diagram of an obtuse angle and label it.

(e) How many degrees are there in:

(i) A right angle? (ii) A straight angle?

6. Draw the following angles using a protractor:

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

7. Identify and classify the angles in a clock:

(a) The angle at 3:00.

(b) The angle at 1:00.

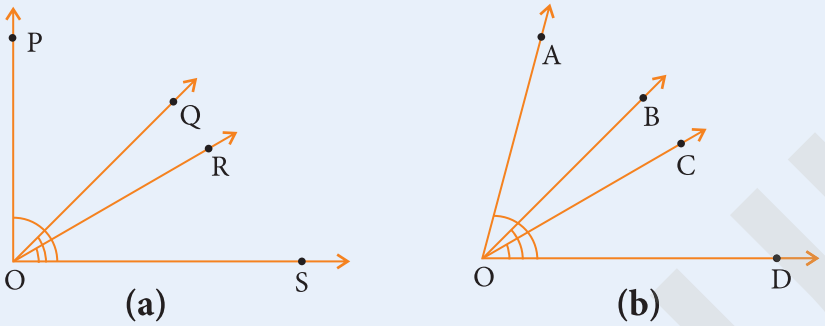
(c) The angle at 10:10.

(i) (ii) (iii)

8. Two angles are complementary. If one angle is 35°, find the other angle.

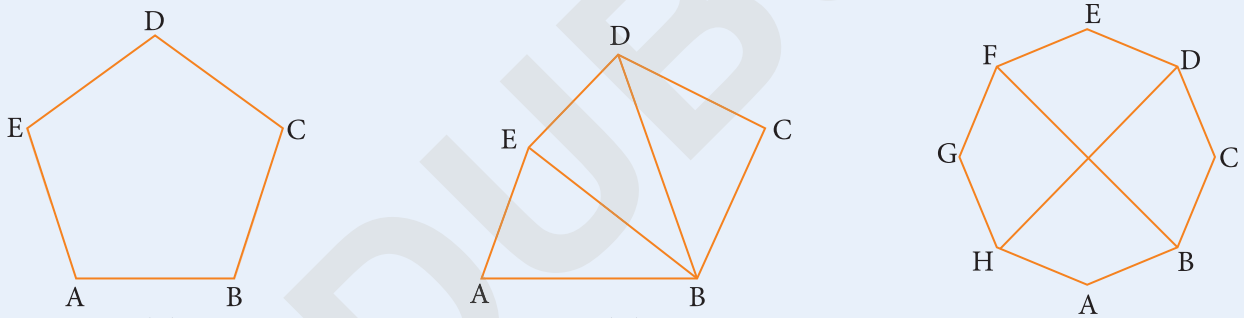
9. Two angles are supplementary. If one angle is 125°, find the other angle.

10. Name all the angles marked in the given figure.



(a) (b)

11. Name all the angles in the given figure.



(a) (b) (c)

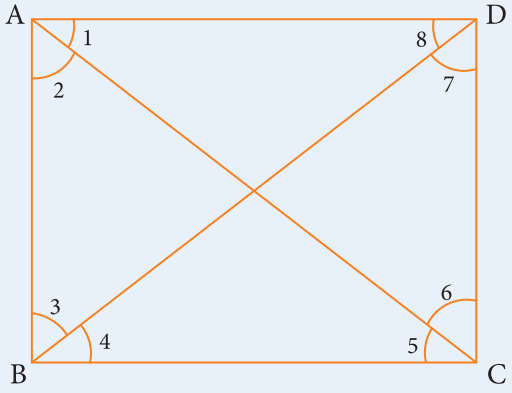
12. Answer the following questions on the basis of figure:

(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

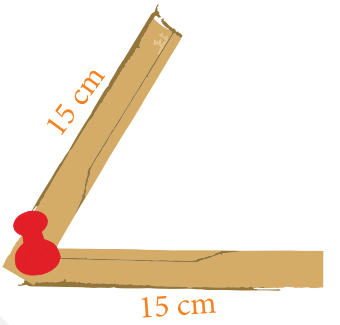


Making Rotating Arms to Understand Angles

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

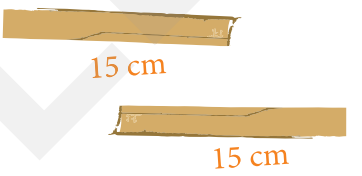
1. Two straight strips of cardboard or thick paper (to act as arms).
2. A push pin or paper fastener (to act as the vertex).
3. A protractor (to measure angles).
4. A sheet of paper or a cardboard base.



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.

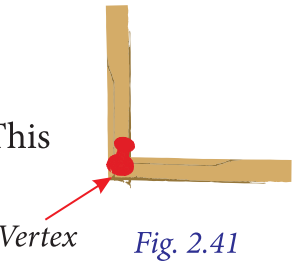


Fig. 2.41

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).

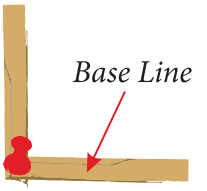


Fig. 2.42

5. Rotate the Second Arm:

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

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.

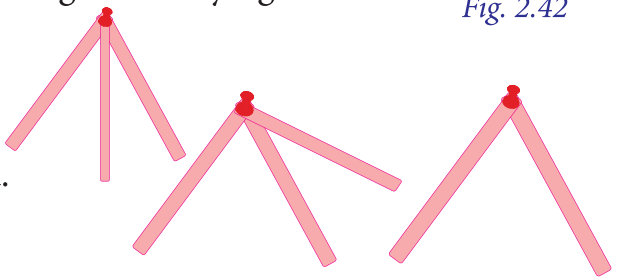
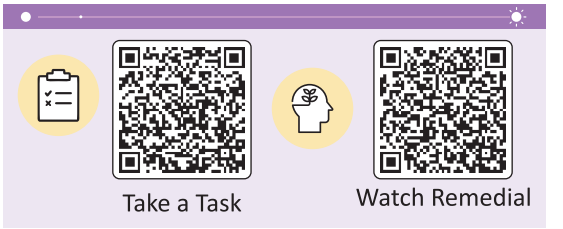


Fig. 2.43

3. Accurate Measurement:

- Using a protractor with the rotating arms helps students connect theory with practice.

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

- **Definition:** An angle that measures less than 90°.
- **Examples:** 30°,45°,60°.
- **Diagram:** A small "V" shape.

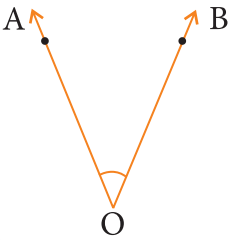


Fig. 2.44

2. Right Angle

- **Definition:** An angle that measures exactly 90°.
- **Examples:** 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.

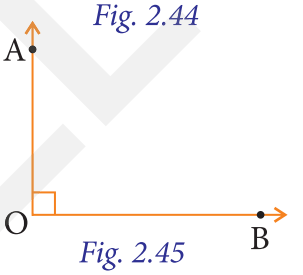


Fig. 2.45

3. Obtuse Angle

- **Definition:** An angle that measures greater than 90° but less than 180°.
- **Examples:** 120°,135°,150°.
- **Diagram:** A wide-open angle.

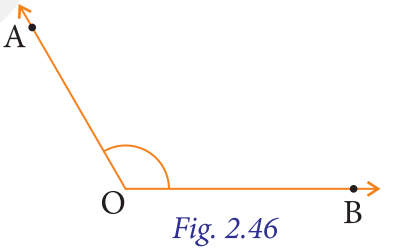


Fig. 2.46

4. Straight Angle

- **Definition:** An angle that measures exactly 180°.
- **Examples:** A straight line forms a straight angle.
- **Diagram:** A straight line.

Fig. 2.47

5. Reflex Angle

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

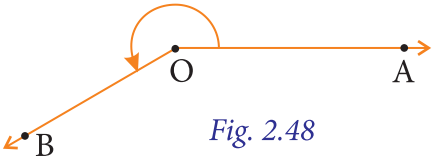


Fig. 2.48

6. Complete Angle

- **Definition:** An angle that measures exactly 360°.
- **Examples:** A full circle represents a complete angle.
- **Diagram:** A full circle.

Fig. 2.49

7. Complementary Angles

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

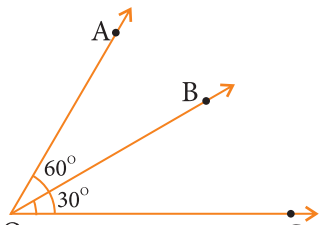


Fig. 2.50

8. Supplementary Angles

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

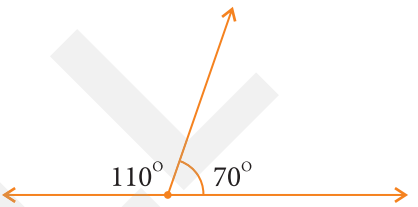


Fig. 2.51

9. Adjacent Angles

- **Definition:** Two angles are called adjacent if:
  1. They share a common vertex.
  2. They share a common arm.
  3. They do not overlap.

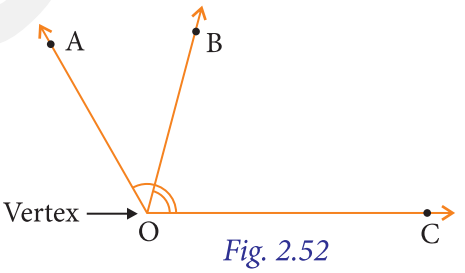


Fig. 2.52

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

10. Vertically Opposite Angles

- **Definition:** 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°.

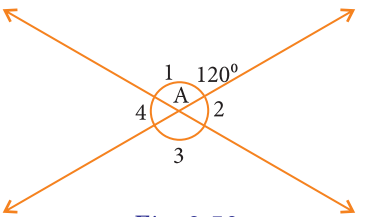


Fig. 2.53

Example : 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?

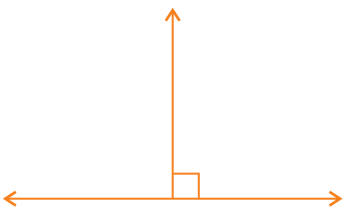


Fig. 2.54

Solution:

(i) 90°

(ii) 180°

(iii) 360°

(iv) $180° = 2 \times 90° = 180°$

(v) $270° = 3 \times 90° = 270°$

(vi) $360° = 4 \times 90° = 360°$

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

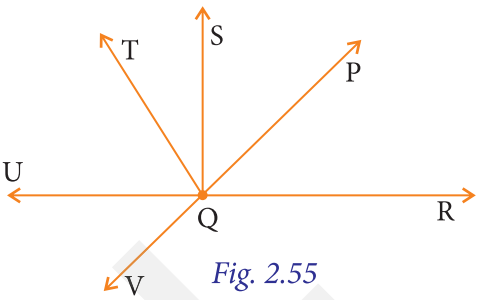


Fig. 2.55

Angles: ∠PQR, ∠QRS, ∠RST, ∠PST, ∠PQS, ∠QRT, ∠RST, ∠PQR, ∠QST

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

Example : From Fig. 3.16, write the measurement and then classify each angle:

(i) ∠MON = 30°

(ii) ∠NOR = 120°, ∠NOR

(iii) ∠QOS = 90°

(iv) ∠NOS = 180°, ∠NOS

(v) ∠POR = 90°

(vi) ∠NOU = 270°

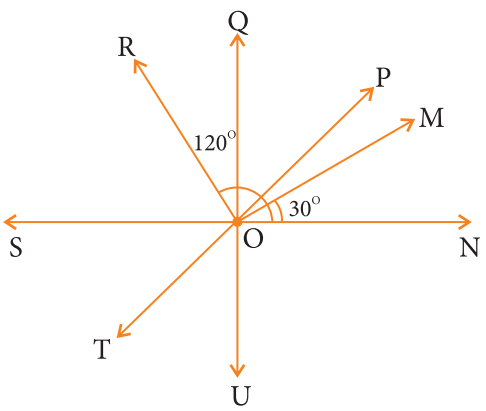


Fig. 2.56

Solution:

(i) Acute Angle

(ii) Obtuse Angle

(iii) Right Angle

(iv) Straight Angle

(v) Right Angle

(vi) Reflex Angle

Example : 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

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. Does the following statement stand True (T) or False (F):

(a) An obtuse angle is smaller than a right angle.

(b) A straight angle measures 180°.

(c) Two complementary angles add up to 180°.

(d) A complete angle is equal to 360°.

(e) Vertically opposite angles are always equal.

3. 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°

4. Match the Following:

Column A	**Column B**
i. Acute Angle	a. 90°
ii. Right Angle	b. Less than 90°
iii. Obtuse Angle	c. 360°
iv. Straight Angle	d. 180°
v. Complete Angle	e. Greater than 90°

5. Short Answer Questions:

(a) What is the measure of a straight angle?

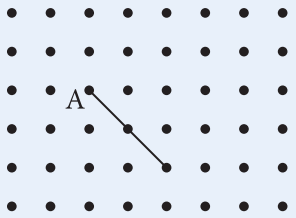
(b) Give one example of complementary angles.

(c) How many degrees are in a reflex angle?

(d) Explain how you can use rotating arms to demonstrate complementary angles.

(e) Describe the process of making rotating arms.

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



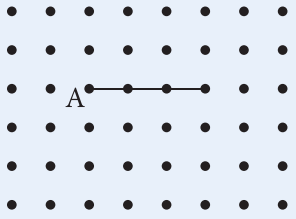
(a) An acute angle.

(b) An obtuse angle.

(c) A reflex angle.

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

7. **In Fig., extend a line through point A to divide the given straight angle into:**



(a) Two acute angles.

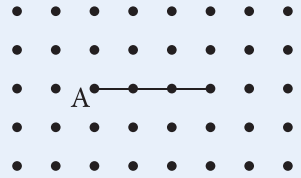
(b) Two obtuse angles.

8. **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.

(a) (b) (c) (d) (e) (f)

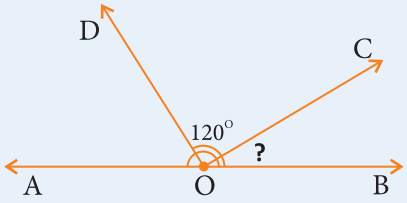
9. **In a similar grid diagram, join A to other grid points to form:**



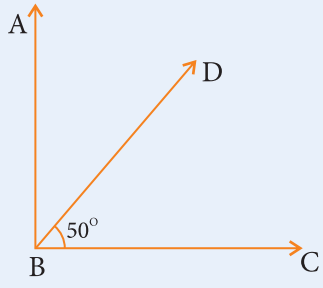
(a) A complementary pair of angles.

(b) A supplementary pair of angles.

10. **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°**



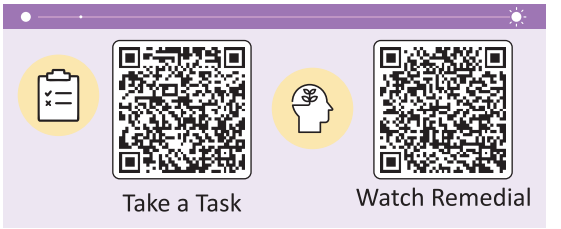
11. **In the given figure, ∠ABC is a right angle (90°). If ∠ABD is a part of ∠ABC, and ∠DBC=50°, find the measure of ∠ABD.**



12. **Give two examples each of right, acute, and obtuse angles from your surroundings.**

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

- 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.

Fig. 2.57

Step 2: Mark the Vertex

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

Fig. 2.58

Step 3: Place the Protractor

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

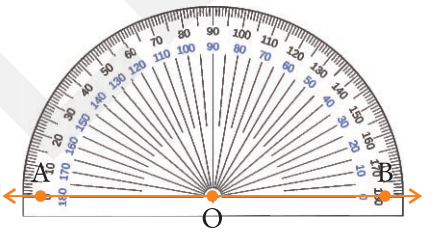


Fig. 2.59

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 mark your angle).
- Mark the point where this degree lies (e.g., point C).

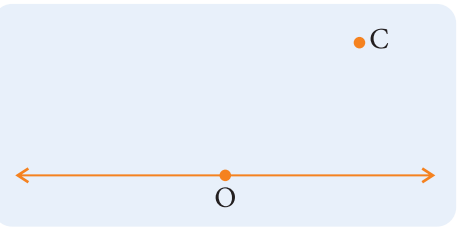


Fig. 2.60

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.

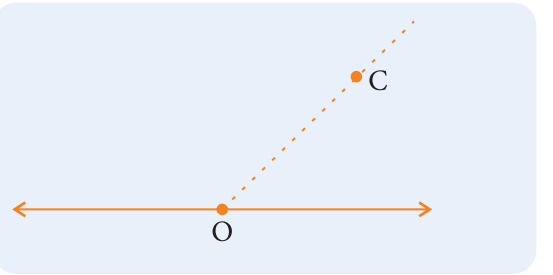


Fig. 2.61

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.

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.

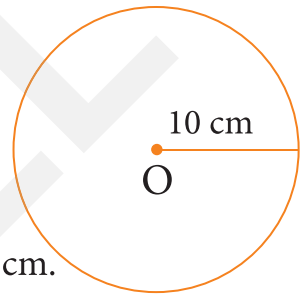


Fig. 2.62

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.

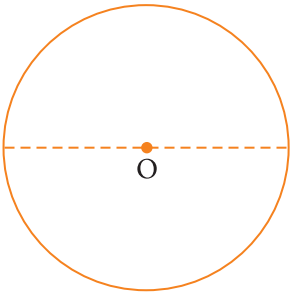


Fig. 2.63

Step 3: Mark the Degrees

1. 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°.
2. Using the ruler and pencil, divide the curve into smaller intervals:
   ✦ 0°,10°,20°,…,180°.
3. Add additional markers for smaller intervals (e.g., 5°) if you want more precision.

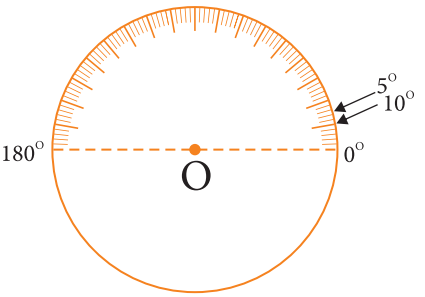


Fig. 2.64

Step 4: Add Lines for Angle Measurements

1. From the center O, draw straight lines to each marked degree on the semi-circle.

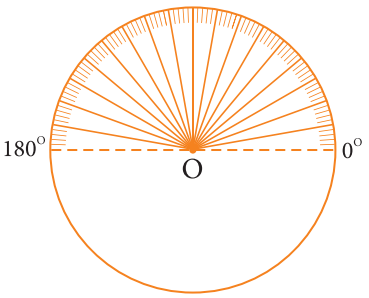


Fig. 2.65

2. These lines represent the arms of different angles (e.g., 30°, 60°, 90°,…).

Step 5: Label the Protractor

1. Write the degree values along the curved edge:
   - ✦ 0°, 10°, 20°,…,180°.
2. Highlight key angles like 90° and 180° with a marker for easy identification.

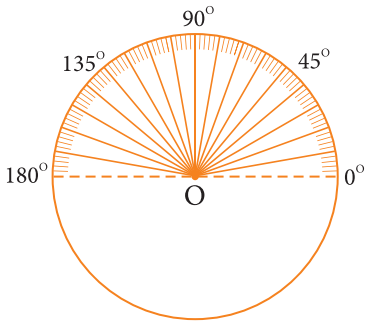


Fig. 2.66

Step 6: Cut It Out

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

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.

Activity Time

Activity with your Protractor;

1. **Measure Angles:** Use your protractor to measure angles in your surroundings (e.g., book corners, open doors).
2. **Draw Angles:** Draw angles like 35°, 75° and 120° using your protractor.
3. **Test Accuracy:** Compare your DIY protractor with a standard protractor to check its accuracy.

Exercise 2.5

1. Provide the missing information in the blanks:

(a) A protractor is used to _____ and _____ angles.

(b) The baseline of the protractor is a _____ line.

(c) The center point of a protractor is called the _____.

(d) A protractor is usually divided into _____ degrees.

(e) To measure a 90° angle, align the _____ with one arm of the angle.

2. What is the purpose of the baseline on a protractor?

(a) To draw lines

(b) To align one arm of the angle

(c) To divide the protractor into degrees

(d) To measure reflex angles

3. **Which of the following is a step in making a protractor?**

   (a) Divide a semi-circle into equal parts.

   (b) Draw a rectangle and mark degrees.

   (c) Create a curved edge with random markings.

   (d) Use a ruler to draw parallel lines.

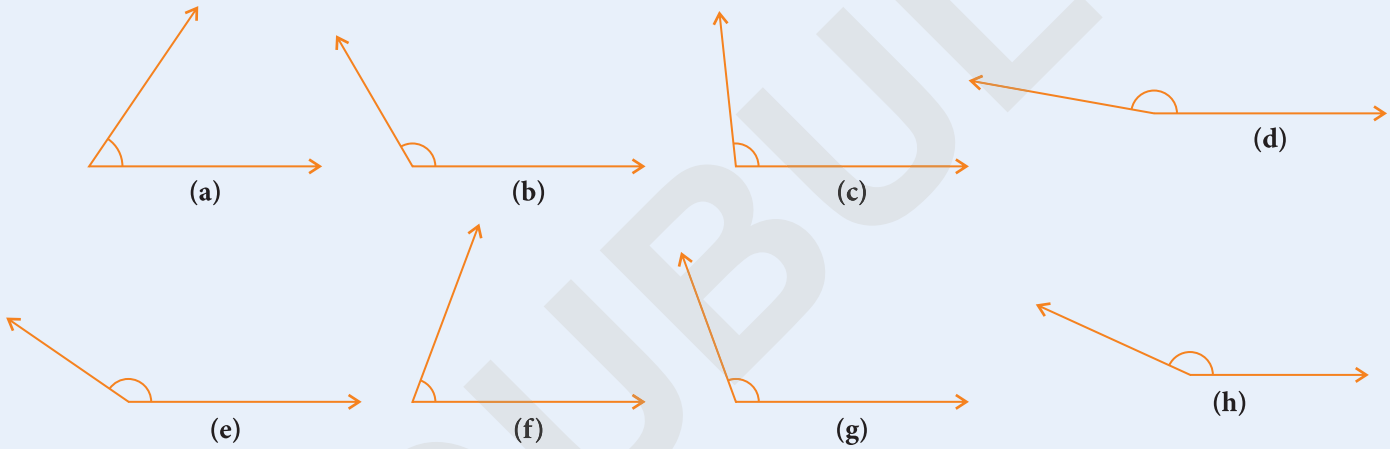
4. **If you divide a full circle into 12 equal parts, what will be the degree measure of each part?**

5. **Draw the angles of the following measures using a protractor:**

   (a) 70° (b) 120° (c) 45° (d) 90°

6. **Draw an angle of 150° and bisect it.**

7. **Estimate the size of each angle below and then measure it with a protractor. Classify the following angles as acute, right, obtuse, or reflex angles:**



8. **Does the following statement stand True (T) or False (F):**

   (a) A protractor is used to draw curves.

   (b) The degree markings on a protractor range from 0° to 360°

   (c) The center hole of the protractor should be placed at the vertex of the angle.

   (d) A protractor can be used to draw both acute and obtuse angles.

   (e) The straight edge of a protractor is called the baseline.

Think Tank

Gap Analyzer™
Take a Test

1. **Tick (✓) the correct answer:**

   a. A straight angle measures:

   (i) 90° ☐ (ii) 180° ☐ (iii) 360° ☐ (iv) 0° ☐

b. Two angles whose sum is 90° are called:

(i) Complementary angles ☐ (ii) Supplementary angles ☐

(iii) Adjacent angles ☐ (iv) Reflex angles ☐

c. How many right angles are there in a complete angle?

(i) 1 ☐ (ii) 2 ☐ (iii) 3 ☐ (iv) 4 ☐

d. If one angle is 70°, its complement is:

(i) 110° ☐ (ii) 90° ☐ (iii) 20° ☐ (iv) 50° ☐

e. In a pair of supplementary angles, one angle is 110°. The other angle is:

(i) 60° ☐ (ii) 70° ☐ (iii) 50° ☐ (iv) 90° ☐

2. Provide the missing information in the blanks:

a. An angle greater than 90° but less than 180° is called an _____ angle.

b. The sum of the angles on a straight line is always _____ degrees.

c. The angle formed by the hands of a clock at 3 o'clock is _____ degrees.

d. If two angles are adjacent and their sum is 180°, they are called _____ angles.

e. A right angle measures exactly _____ degrees.

3. Three angles of a quadrilateral measure 95°, 85°, and 75°. Find the fourth angle.

4. Two angles are supplementary, and one angle is 78°. What is the measure of the other angle?

5. Match the Columns:

Column A	Column B
a) Right angle	i) Greater than 180°
b) Straight angle	ii) Less than 90°
c) Acute angle	iii) Equal to 90°
d) Reflex angle	iv) Equal to 180°

Custom Learning Path

Scan to Create Your Own Learning Path

Assertion and Reason

Experiential Learning

Each question has two statements, Assertion (A) and Reason (R). Choose the correct option:

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 (A):** The sum of complementary angles is always 90°.
   Reason (R): Complementary angles are always adjacent.

Each question has two statements, Assertion (A) and Reason (R). Choose the correct option:

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 (A):** The sum of complementary angles is always 90°.
   Reason (R): Complementary angles are always adjacent.
2. **Assertion (A):** A straight line forms an angle of 180°.
   Reason (R): A straight angle is the sum of two right angles.
3. **Assertion (A):** A pair of vertically opposite angles are always equal.
   Reason (R): Vertically opposite angles are formed when two lines intersect.
4. **Assertion (A):** Two angles measuring 120° and 60° are complementary.
   Reason (R): Complementary angles have a sum of 180°.
5. **Assertion (A):** Adjacent angles can be supplementary.
   Reason (R): Adjacent angles share a common vertex and a common arm.

HOTS (Higher Order Thinking Skills)

Critical Thinking

1. The hands of a clock form an obtuse angle at 8:20. Estimate the angle formed between them.
2. Three angles of a quadrilateral measure 90°, 80°, and 110°. Find the fourth angle.
3. A triangle has two angles measuring 65° and 55°. Classify the triangle based on its angles and find the third angle.

Case Study

A playground has a walking track designed in a triangular shape. The angles at the three corners of the track are marked as follows:

- Angle A is 90°,
- Angle B is 45°,
- Angle C is unknown.

The track also has straight sections where corners meet, forming supplementary angles.

Questions:

1. What is the measure of Angle C?
2. What is the total sum of the three angles in the triangular walking track?
3. If the angle on the straight path adjacent to Angle B is x, what is the value of x?
4. Classify the triangle based on its angles.
5. Explain why the sum of the three angles in a triangle is always 180°.