Chapter 2

LINES AND ANGLES

Class 6 Mathematics | Ganita Prakash | NCERT

Topics Covered in This Chapter

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Complete Notes with Concept Explanations, Diagrams & Step-by-Step Solutions

Space for your own notes

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2.1 Point

A point determines a precise location on a surface. It has no length, breadth or height. We represent it by a tiny dot made with a sharp pencil tip. Points are labelled using capital letters.

Real-life models of a Point:

- Tip of a compass
- Sharpened end of a pencil
- Pointed end of a needle

A point is denoted by a capital letter e.g. Point P, Point A, Point Z

Three points on paper are named as P, Z and T. The dots represent exact locations and must be imagined to be invisibly thin.

Diagram: P • Z • T •

2.2 Line Segment

Activity: Fold a piece of paper and unfold it. The crease formed gives an idea of a line segment.

The shortest path between two points A and B (including A and B) is called a Line Segment. It is denoted by $\overline{AB}$ or $\overline{BA}$.

Diagram: A •—————————————————• B

A line segment has TWO END POINTS and a DEFINITE (measurable) LENGTH.

Feature	Description
End points	Two fixed points A and B
Length	Finite — can be measured
Direction	Goes from A to B (or B to A)
Notation	AB or BA (with bar on top)

2.3 Line

Imagine extending line segment AB beyond A in one direction and beyond B in the other direction, without any end. This gives us a Line.

Diagram: ←————————A •——————————• B————————→ (line m)

Any TWO points determine a UNIQUE line passing through both of them.

Feature	Line	Line Segment
End points	None	Two
Length	Infinite	Finite
Can be drawn fully?	No	Yes

Notation	AB (double arrow) or m	AB (bar on top)

2.4 Ray

A Ray is a portion of a line that starts at one point (called the starting point or initial point) and goes on endlessly in one direction.

Diagram: O •———————————• P ———————————→

Real-life examples of a Ray:

- Beam of light from a lighthouse
- Ray of light from a torch
- Sun rays

Feature	Ray	Line Segment	Line
Starting point	Yes (1 point)	Yes (2 points)	None
End point	None	Yes (1 point)	None
Length	Infinite	Finite	Infinite
Direction	One way	Both ways	Both ways

Figure it Out

Q.1. Can you help Rihan and Sheetal find their answers?

Rihan marked a point — how many lines can he draw through it?

Sheetal marked two points — how many lines pass through both?

Ans.

Rihan: Through a single point, infinitely many lines can be drawn.

Sheetal: Through two given points, exactly ONE unique line can be drawn.

Rihan → Infinitely many lines | Sheetal → Exactly 1 unique line

Q.2. Name the line segments in Fig. 2.4. Which points are on exactly one segment? Which are on two?

Ans.

Line segments: LM, MP, PQ, QR

Points on exactly ONE segment: L and R

Points on TWO segments: M, P, Q

LM, MP, PQ, QR | L & R → one segment | M, P, Q → two segments

Q.3. Name the rays shown in Fig. 2.5. Is T the starting point of each ray?

Ans.

Rays: TA, TB, TN and NB

No. T is the starting point of TA, TB and TN, but NOT of NB. (N is the starting point of NB.)

T is NOT the starting point of ray NB.

Q.4. Draw rough figures to illustrate each of the following:

(a) OP and OQ meet at O: Draw two rays from common point O — one toward P and one toward Q.

(b) XY and PQ intersect at M: Draw ray XY and line PQ crossing at point M.

(c) Line l contains E and F but not D: Draw line l through E and F; mark D away from the line.

(d) Point P lies on AB: Draw line segment AB with point P marked between A and B.

Q.5. In Fig. 2.6, name: (a) Five points (b) A line (c) Four rays (d) Five line segments

Ans.

(a) Five Points	D, E, O, B, C
(b) A Line	DE or DO or DB or EO or EB
(c) Four Rays	OC, OB, OE, OD (arrows pointing outward)
(d) Five Line Segments	DE, DO, DB, EO, EB (and also OB, OC)

Q.6. Ray OA starts at O, passes through A and B. (a) Name it as OB? (b) Write OA as AO?

Ans.

(a) Yes! Since O is the starting point and B lies on the same ray, OA = OB (same ray).

(b) No! OA starts at O; AO starts at A. They are DIFFERENT rays going in opposite directions.

OA = OB (same ray) | OA ≠ AO (different starting points)

2.5 Angle

An angle is formed by two rays having a common starting point. The common point is called the vertex and the two rays are called the arms.

Diagram: Vertex O → Arms OD and OB → Angle = ∠DOB

Part	Name	Example
Common starting point	Vertex	Point O in ∠DOB
Two rays	Arms	OD and OB
The angle	∠DOB or ∠BOD	Vertex always in the middle

Size of an angle = Amount of rotation to move one arm to the other.

Real-life examples of Angles:

Scissors: When blades open, they form an angle. Vertex = pivot. Arms = the two blades.

Clock hands: The two hands make angles at different times. At 3 o'clock = 90°.

Opening a book: The cover rotates about the spine forming an angle.

Compass / Divider: Arms are turned to form different angles. Vertex = joining point.

Figure it Out

Q.1. Find angles in the given pictures. Draw rays forming one angle and name the vertex.

Ans.

In the bicycle picture: ∠BDC (at the frame joint). Vertex = D, Arms: DB and DC.

In the tile picture: multiple angles at the intersection of strips.

Vertex is the point where two rays meet.

Q.2. Draw and label an angle with arms ST and SR.

Ans.

Draw two rays from common point S — one toward T, one toward R.

The angle formed: ∠TSR (or ∠RST). Vertex = S, Arms = ST and SR.

Q.3. Explain why ∠APB cannot be labelled as ∠P.

Ans.

In the figure, more than two rays start from point P (rays PA, PB and PC).

Labelling just ∠P would be ambiguous — we would not know which pair of arms is meant.

We must write ∠APB to clearly specify the two arms.

∠P is ambiguous when more than 2 rays emerge from P. Always use ∠APB.

Q.4. Name the angles marked in the given figure (with rays P, Q, T, R).

Ans.

The two marked angles are: ∠PTR and ∠PTQ

Angles: ∠PTR and ∠PTQ (Vertex = T)

Q.5. Mark three non-collinear points A, B, C. Draw all lines and name all angles.

Ans.

Number of lines: 3 → Lines AB, BC, CA

Angles using A, B, C: ∠ABC (or ∠CBA), ∠BCA (or ∠ACB), ∠CAB (or ∠BAC)

3 lines | 3 angles: ∠ABC, ∠BCA, ∠CAB

Q.6. Mark four points A, B, C, D (no three collinear). Draw all lines and list angles.

Ans.

Number of lines = 6: AB, BC, CD, DA, AC, BD

Angles using A, B, C, D (12 angles):

∠BAC, ∠CAD, ∠BAD, ∠ADB, ∠BDC, ∠ADC, ∠DCA, ∠ACB, ∠DCB, ∠CBD, ∠DBA, ∠CBA

6 lines | 12 angles

2.6 Comparing Angles

We can compare the sizes of two angles by the method of superimposition — placing one angle over the other with vertices overlapping.

Case	What happens?	Conclusion
Arm of angle 1 is inside angle 2	One fits inside the other	Angle 2 > Angle 1
Arms overlap perfectly	Both arms coincide	Angle 1 = Angle 2
Arm of angle 2 is inside angle 1	Other fits inside	Angle 1 > Angle 2

Equal Angles: When superimposed, both arms completely overlap each other.

We can also compare angles using a transparent circular disc — place its centre on the vertex and mark where the arms cross the circle.

Figure it Out

Q.1. Fold a rectangular paper and compare angles formed between fold and sides.

Ans.

When you fold and draw a line along the crease, four angles are formed: ∠AEF, ∠BEF, ∠DFE, ∠CFE.

∠AEF and ∠CFE are larger than ∠BEF and ∠DFE (depends on the fold angle).

Try various folds to make different angles and compare them!

Q.2. Determine which angle is greater (refer to figure with rays OA, OX, OB, OC, OY):

Ans.

(a) ∠AOB or ∠XOY	∠AOB > ∠XOY (since ∠AOB = ∠AOX + ∠XOY + ∠YOB)
(b) ∠AOB or ∠XOB	∠AOB > ∠XOB (ray OA is beyond OX)
(c) ∠XOB or ∠XOC	∠XOB = ∠XOC (C lies on OB — same ray)

Q.3. Which is greater: ∠XOY or ∠AOB? (Given figure)

Ans.

By looking at the figure alone, we CANNOT say. Superimposition or measurement is NECESSARY.

We need superimposition or measurement to compare ∠XOY and ∠AOB.

2.7 Making Rotating Arms

Activity: Make "rotating arms" using two paper straws and a paper clip.

Step 1: Take two paper straws and a paper clip.

Step 2: Insert the straws into the arms of the paper clip.

Step 3: Your rotating arm is ready! Adjust the angle between the arms.

Key Observation – Passing through a Slit:

Condition	What happens?
Slit angle > Arm angle	Arms are smaller than slit — do NOT fill the slit exactly.
Slit angle < Arm angle	Arms are wider than slit — they do NOT pass through.
Slit angle = Arm angle	Arms fit EXACTLY through the slit. ✓

Passing through a slit depends ONLY on the ANGLE — not on the length of the arms!

2.8 Special Types of Angles

By observing Vidya opening her notebook cover in different ways, we discover special angles:

Angle Type	Degree Measure	Description	Example

Acute	$0° < \theta < 90°$	Less than a right angle — "sharp"	40°, 75°
Right	$\theta = 90°$	Quarter turn; looks like the letter L	Corner of a book
Obtuse	$90° < \theta < 180°$	Greater than right, less than straight	110°, 135°
Straight	$\theta = 180°$	Half turn; forms a straight line	Flat surface
Reflex	$180° < \theta < 360°$	Greater than straight angle	270°
Complete	$\theta = 360°$	One full rotation	Clock full spin

Straight angle = 2 Right angles | Full turn = 4 Right angles = 360°

Right Angles and Perpendicular Lines:

- A straight angle (180°) divided into two equal parts gives two right angles (90°).
- Two lines meeting at a right angle are called Perpendicular Lines.
- A right angle resembles the shape of the letter "L".

Figure it Out

Q.1. How many right angles do classroom windows contain? Where else do you see right angles?

Ans.

Each rectangular window has 4 right angles (one at each corner).

Other right angles in classroom: corners of the blackboard, door frame, table edges, book corners, floor tiles.

Each rectangular window has 4 right angles.

Q.4. Get a slanting crease on paper. Get another crease perpendicular to it.

(a) How many right angles? Justify. (b) Describe the folding process.

Ans.

(a) 4 right angles are formed. Each is exactly 1/4 of a complete turn ($360° \div 4 = 90°$).

(b) Process:

Step 1: Fold the paper to get a slanting crease (line l_1).

Step 2: Fold again so that line l_1 overlaps itself — this creates crease l_2 perpendicular to l_1.

Step 3: Unfold — you have two perpendicular lines forming 4 right angles.

4 right angles are formed when two perpendicular lines cross.

Q. Classify angles: What are "acute" and "obtuse" and why are these words chosen?

Ans.

Type	Range	Meaning
Acute	0° – 90°	"Sharp" — small opening, like a sharp knife tip
Right	= 90°	Exactly a quarter turn
Obtuse	90° – 180°	"Blunt" — wider opening, like a blunt knife
Straight	= 180°	Half turn; flat line

Q. Find the number of acute angles in each figure (triangle series).

Ans.

Figure	Inner triangles	Acute angles
Figure 1 (single triangle)	0	3
Figure 2 (4 triangles)	1	12
Figure 3 (9 triangles)	2	21
Figure 4 (next)	3	30

Pattern: 3, 12, 21, 30, ... (increases by 9 each time) | Formula: 3 + 9n (n = number of inner triangles)

Pattern: 3, 12, 21, 30 ... (difference = 9 each time)

2.9 Measuring Angles

To assign an exact number to the size of an angle, mathematicians divided the full circle (full turn) into 360 equal parts. Each part is called 1 degree (1°).

Full circle = 360° | Straight angle = 180° | Right angle = 90° | 1° = 1 unit part

Why 360?

- The Rigveda mentions a wheel with 360 spokes.
- Ancient Indian, Persian, Babylonian and Egyptian calendars had 360 days in a year.
- 360 is divisible by 1, 2, 3, 4, 5, 6, 8, 9, 10, 12 and 24 — very convenient!
- 360 = 12 months × 30° or 360 = 24 hours × 15°

Angle	Turn	Degrees
Full turn	1 complete	360°
Straight angle	1/2 turn	180°
Right angle	1/4 turn	90°
Half right angle	1/8 turn	45°
One degree	1/360 turn	1°

The Protractor:

A protractor is a tool used to measure angles. It is a semicircle divided into 180 equal parts (each = 1°).

[Protractor — Semicircle with 0° on right, 90° at top, 180° on left, centre = vertex point]

How to use a Protractor:

Step 1: Place the CENTRE of the protractor on the VERTEX of the angle.

Step 2: ALIGN one arm of the angle with the 0° line of the protractor.

Step 3: Read the degree measure where the OTHER ARM crosses the protractor scale.

Step 4: Choose the CORRECT scale (inner or outer) based on which arm aligns to 0°.

Note: The protractor has an inner scale (right→left: 0°→180°) and an outer scale (left→right: 0°→180°). Use the scale where your base arm aligns to 0°.

Figure it Out

Q.1. Write the measures of angles ∠KAL, ∠WAL, ∠TAK using the unlabelled protractor.

Ans.

Angle	How to find	Measure
∠KAL	Count units between KA and AL	30°
∠WAL	Count units between WA and AL	50°
∠TAK	Count units between TA and AK	120°

Q. Name angles and find measures (labelled protractor: O at centre, rays P, Q, R, S, T, U):

Ans.

Angle	Measure	Angle	Measure	Angle	Measure
∠POQ	35°	∠QOR	60°	∠ROS	30°
∠POR	95°	∠QOS	90°	∠ROT	65°
∠POS	125°	∠QOT	125°	∠ROU	85°
∠POT	160°	∠QOU	145°	∠SOT	35°
∠TOU	20°	∠SOU	55°		

Q.6. Find ∠BXE, ∠CXE, ∠AXB, ∠BXC from the figure with protractor.

Ans.

∠BXE = 115°	**∠CXE = 85°**	**∠AXB = 65°**	**∠BXC = 30°**

Q.7. Find ∠PQR, ∠PQS, ∠PQT.

Ans.

∠PQR = 45°	**∠PQS = 100°**	**∠PQT = 150°**

Q.9. Measure all three angles of each triangle and find their sum.

Ans.

For ANY triangle, the sum of all three angles is always 180°.

This is the famous Angle Sum Property of a Triangle.

Sum of angles in any triangle = 180°

Angles in a Clock (Real-life Application):

Time	Angle	Reason
1 o'clock	30°	360° ÷ 12 = 30° per hour gap
2 o'clock	60°	2 × 30°
3 o'clock	90°	3 × 30° (right angle)
4 o'clock	120°	4 × 30° (obtuse angle)
6 o'clock	180°	6 × 30° (straight angle)
9 o'clock	270°	9 × 30° (reflex angle)

2.9 (cont.) Angle Bisector

At each paper-folding step, we divide an angle into two equal halves. This process is called bisecting the angle. The line (ray) that divides an angle into two equal parts is called the Angle Bisector.

Diagram: OC bisects ∠AOB → ∠AOC = ∠COB = 30° (if ∠AOB = 60°)

OC is the angle bisector of ∠AOB ⟹ ∠AOC = ∠COB = (1/2) × ∠AOB

Making a Protractor by Paper Folding:

Fold Step	Fraction of full turn	Angle
Cut circle in half (semicircle)	1/2 turn	180°
Fold semicircle in half	1/4 turn	90°
Fold again in half	1/8 turn	45° and 135°
Fold once more in half	1/16 turn	22.5°, 67.5°, 112.5°, 157.5°

Think! ∠AOB = ∠BOC = ∠COD = ... = ∠HOI = ? (from Fig. 2.19)

Ans.

Each angle = 22.5° (since 180° is divided into 8 equal parts: 180° ÷ 8 = 22.5°)

Each equal angle = 22.5°

2.10 Drawing Angles

Example: Draw ∠TIN = 30°

Step 1: Draw the base ray IN (I is the vertex, N is a point on the arm).

Step 2: Place the centre of the protractor on vertex I. Align the base ray IN with the 0° line.

Step 3: Starting from 0°, count up to 30° on the protractor. Mark point T at 30°.

Step 4: Using a ruler, join I and T. The angle ∠TIN = 30° is drawn.

Figure it Out

Q.2. Use a protractor to draw angles: 110°, 40°, 75°, 112°, 134°

Ans.

Method (same for all angles):

Step 1: Draw a base ray OB.

Step 2: Place protractor centre on O; align OB with the 0° mark.

Step 3: Mark the required angle on the correct scale (inner or outer).

Step 4: Join O to the marked point. This is the second arm of the angle.

Angle	Type	Notes
110°	Obtuse	Count from 0° on the appropriate scale
40°	Acute	Count from 0° on the appropriate scale
75°	Acute	Count from 0° on the appropriate scale
112°	Obtuse	Count from 0° on the appropriate scale

134°	Obtuse	Count from 0° on the appropriate scale

2.11 Types of Angles and Their Measures

Type	Symbol	Range	Real Example
Acute	∠	0° < angle < 90°	Opening a book slightly
Right	⊾	angle = 90°	Corner of a room
Obtuse	∠	90° < angle < 180°	Open book more than flat
Straight	—	angle = 180°	Flat surface
Reflex	↺	180° < angle < 360°	Major arc of a sector
Complete	○	angle = 360°	Full rotation of clock hands

Figure it Out

Q.2. Use a protractor to find the measure of each angle and classify.

Ans.

Angle	Measure	Type
∠PTR	30°	Acute
∠PTQ	60°	Acute
∠PTW	102°	Obtuse
∠WTP	258°	Reflex

Let's Explore: ∠TER = 80°. Find ∠BET and ∠SET.

Ans.

Step 1: ∠REB is a straight angle (B, E, R are collinear) → ∠REB = 180°

Step 2: ∠BET = ∠REB - ∠TER = 180° - 80° = 100°

Step 3: ∠SET = 90° - 80° = 10° (ES is perpendicular to ER)

∠BET = 100°	**∠SET = 10°**

Q.1. Draw angles with degree measures: 140°, 82°, 195°, 70°, 35°

Ans.

Angle	Type	Note
140°	Obtuse	Draw base ray, measure 140° from 0°
82°	Acute	Draw base ray, measure 82° from 0°
195°	Reflex	Draw the reflex side (360° - 165° = 195°)
70°	Acute	Draw base ray, measure 70° from 0°
35°	Acute	Draw base ray, measure 35° from 0°

Q.6. The Ashoka Chakra has 24 spokes. Find: (a) angle between adjacent spokes, (b) largest acute angle.

Ans.

Step 1: Full circle = 360°. Number of equal parts = 24.

Step 2: Angle between two adjacent spokes = 360° ÷ 24 = 15°

Step 3: Acute angles < 90°. Largest multiple of 15° less than 90° is 75° (= 5 × 15°).

Angle between adjacent spokes = 15°	Largest acute angle = 75°

Q.7. Puzzle: I am an acute angle. Doubled → acute. Tripled → acute. Quadrupled → acute. × 5 → obtuse.

Ans.

Let the angle = x°. Conditions:

$0° < x < 90°$ → x is acute

$0° < 2x < 90°$ → $x < 45°$

$0° < 3x < 90°$ → $x < 30°$

$0° < 4x < 90°$ → $x < 22.5°$

$90° < 5x < 180°$ → $18° < x < 36°$

Combining: $18° < x < 22.5°$ → whole number values: **x = 19°, 20°, 21° or 22°**

Answer: x can be 19°, 20°, 21° or 22°

CHAPTER SUMMARY — Lines and Angles

Term	Definition / Key Fact
Point	Determines a precise location; no size. Denoted by a capital letter.
Line Segment	Shortest path between two points; has two end points; finite length. Notation: AB
Line	Extends infinitely in both directions; no end points. Notation: AB (double arrow) or m
Ray	Starts at one point, goes endlessly in one direction. Notation: OP (arrow)
Angle	Formed by two rays with common starting point (vertex). Symbol: ∠
Size of Angle	Amount of rotation from one arm to the other arm.
Degree (°)	Unit of angle. Full circle = 360°. 1° = 1/360 of full circle.
Protractor	Tool to measure angles; semicircle divided into 180 equal parts.
Right angle	= 90° (quarter turn). Lines meeting at 90° are perpendicular.
Straight angle	= 180° (half turn). Arms lie on a straight line.
Acute angle	Greater than 0° and less than 90° (between zero and right angle).
Obtuse angle	Greater than 90° and less than 180° (between right and straight).
Reflex angle	Greater than 180° and less than 360°.
Angle Bisector	Ray that divides an angle into two equal halves.
Superimposition	Method to compare angles by placing one over the other.

0° < Acute < 90° = Right < Obtuse < 180° = Straight < Reflex < 360° = Full turn