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CHAPTER NOTES

Straight Lines Class 11 Notes | CBSE Maths Chapter 9

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Straight Lines Class 11 Notes | CBSE Maths Chapter 9

Straight Lines is Chapter 9 of CBSE Class 11 Maths — and it is the chapter that turns geometry into algebra. Give a line a slope and a point, and you can write its exact equation; give two equations, and you can find where the lines cross, the angle between them, or the distance from any point. It is pure coordinate geometry, and once the formulas click, it becomes one of the most scoring chapters in the whole syllabus.

By the end of these notes you will be able to find the slope of any line, write its equation in all five standard forms, measure the angle between two lines, test three points for collinearity, and compute the distance of a point from a line and between two parallel lines. This is a high-weightage chapter carrying roughly 6–8 marks in boards, and the foundation for Conic Sections and Three-Dimensional Geometry.

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Key Concepts

1. Slope (Gradient) of a Line

The **slope** of a line measures how steep it is — how much it rises (or falls) for every unit you move to the right. If a line makes an angle θ with the positive x-axis (measured anticlockwise), then:

$$m = \tan \theta$$

For a line passing through two points (x_1, y_1) and (x_2, y_2) , the slope is the change in y over the change in x:

$$m = (y_2 - y_1)/(x_2 - x_1)$$

- A line going uphill (left to right) has **positive** slope; downhill has **negative** slope.
 - A **horizontal** line has slope 0 ($\theta = 0^\circ$).
 - A **vertical** line has an undefined slope ($\theta = 90^\circ$, $\tan 90^\circ$ is not defined).
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2. Parallel and Perpendicular Lines

Slopes tell you instantly how two lines are related.

- **Parallel lines** have equal slopes: $m_1 = m_2$.
- **Perpendicular lines** have slopes whose product is -1 : $m_1 \times m_2 = -1$, i.e. $m_2 = -1/m_1$.

For example, a line of slope 2 is perpendicular to a line of slope $-1/2$, because $2 \times (-1/2) = -1$.

3. Angle Between Two Lines

If two lines have slopes m_1 and m_2 , the **acute angle θ** between them is given by:

$$\tan \theta = |(m_2 - m_1)/(1 + m_1 m_2)|$$

- If $1 + m_1 m_2 = 0$, the lines are **perpendicular** ($\theta = 90^\circ$).
- If $m_1 = m_2$, the lines are **parallel** ($\theta = 0^\circ$).

The modulus sign ensures we always report the acute angle. Drop the modulus to get the angle including its sign.

4. Collinearity of Three Points

Three points are **collinear** (lie on the same straight line) if the slope between any two pairs is the same.

Points $A(x_1, y_1)$, $B(x_2, y_2)$, $C(x_3, y_3)$ are collinear if:

$$\text{slope of AB} = \text{slope of BC}$$

Equivalently, the area of the triangle they form is zero:

$$\frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)| = 0$$

5. Various Forms of the Equation of a Line

This is the heart of the chapter. Depending on what information you are given, you pick the matching form.

(a) Point-Slope Form

Given a point (x_1, y_1) and slope m :

$$y - y_1 = m(x - x_1)$$

(b) Two-Point Form

Given two points (x_1, y_1) and (x_2, y_2) :

$$y - y_1 = [(y_2 - y_1)/(x_2 - x_1)](x - x_1)$$

(c) Slope-Intercept Form

Given slope m and y -intercept c (where the line cuts the y -axis):

$$y = mx + c$$

If instead you know the x -intercept d , the form is $y = m(x - d)$.

(d) Intercept Form

Given the x -intercept a and y -intercept b :

$$x/a + y/b = 1$$

(e) Normal (Perpendicular) Form

Given the length p of the perpendicular from the origin to the line and the angle ω this perpendicular makes with the positive x -axis:

$$x \cos \omega + y \sin \omega = p$$

Here p is always taken positive, and ω lies between 0° and 360° .

6. General Equation of a Line

Every straight line can be written in the **general form**:

$$Ax + By + C = 0 \text{ (where A and B are not both zero)}$$

You can read off useful quantities by rearranging it:

- **Slope:** $m = -A/B$
 - **x-intercept:** $-C/A$ **y-intercept:** $-C/B$
 - **Slope-intercept form:** $y = (-A/B)x + (-C/B)$
 - **Normal form:** divide through by $\sqrt{A^2 + B^2}$
-

7. Distance of a Point from a Line

The perpendicular distance d of a point (x_1, y_1) from the line $Ax + By + C = 0$ is:

$$d = |Ax_1 + By_1 + C| / \sqrt{A^2 + B^2}$$

This is one of the most frequently tested formulas in the chapter. Just substitute the point into the line expression, take the modulus, and divide by $\sqrt{A^2 + B^2}$.

8. Distance Between Two Parallel Lines

Two parallel lines have the same A and B. For the lines $Ax + By + C_1 = 0$ and $Ax + By + C_2 = 0$:

$$d = |C_1 - C_2| / \sqrt{A^2 + B^2}$$

Important: make sure the coefficients of x and y are identical in both equations before subtracting the constants. If they are not, scale one equation first.

9. Family of Lines

A **family of lines** is the set of all lines passing through the intersection of two given lines. If $L_1 = A_1x + B_1y + C_1 = 0$ and $L_2 = A_2x + B_2y + C_2 = 0$, then any line through their point of intersection is:

$$L_1 + \lambda L_2 = 0$$

where λ is a parameter. You find λ using an extra condition (such as the line passing through a given point or having a given slope). This trick saves you from first solving for the intersection point.

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	6–8 marks	Forms of a line, distance of a point, angle between lines
JEE Main / Advanced	1–3 questions (with Conic Sections)	Family of lines, distance formulas, foot of perpendicular, image of a point
NEET	Not in syllabus	—

[TABLE: Question-type split — VSA (1 mark): slope, intercepts, parallel/perpendicular tests; SA (2–3 marks): equation in a given form, distance of a point, angle between lines; LA (5 marks): family of lines, distance between parallel lines, collinearity proofs.]

Important Definitions

Term	Definition
Slope	Tangent of the angle a line makes with the positive x-axis: $m = \tan \theta$
Inclination	The angle θ ($0^\circ \leq \theta < 180^\circ$) the line makes with the positive x-axis
Parallel lines	Lines with equal slopes: $m_1 = m_2$
Perpendicular lines	Lines whose slopes satisfy $m_1 m_2 = -1$
Collinear points	Points lying on one straight line; slope of AB = slope of BC
Point-slope form	$y - y_1 = m(x - x_1)$
Slope-intercept form	$y = mx + c$
Intercept form	$x/a + y/b = 1$
Normal form	$x \cos \omega + y \sin \omega = p$
General equation	$Ax + By + C = 0$; slope = $-A/B$
Distance of a point from a line	$d = Ax_1 + By_1 + C / \sqrt{A^2 + B^2}$

Solved Examples

Example 1

Find the slope of the line passing through the points (2, 3) and (5, 11).

Answer: $m = (y_2 - y_1)/(x_2 - x_1) = (11 - 3)/(5 - 2) = 8/3$. So the slope is **8/3**.

Example 2

Find the equation of the line passing through (1, 2) with slope 3.

Answer: Point-slope form: $y - 2 = 3(x - 1) \Rightarrow y - 2 = 3x - 3 \Rightarrow \mathbf{3x - y - 1 = 0}$.

Example 3

Find the angle between the lines $y = 2x + 1$ and $y = -3x + 4$.

Answer: $m_1 = 2$, $m_2 = -3$. $\tan \theta = |(m_2 - m_1)/(1 + m_1 m_2)| = |(-3 - 2)/(1 + (2)(-3))| = |-5/-5| = 1$. So $\theta = \mathbf{45^\circ}$.

Example 4

Find the equation of the line with x-intercept 4 and y-intercept -3 .

Answer: Intercept form: $x/a + y/b = 1 \Rightarrow x/4 + y/(-3) = 1$. Multiplying by 12: $3x - 4y = 12$, i.e. **$3x - 4y - 12 = 0$** .

Example 5

Find the perpendicular distance of the point $(3, -5)$ from the line $4x - 3y - 26 = 0$.

Answer: $d = |4(3) - 3(-5) - 26| / \sqrt{(4^2 + (-3)^2)} = |12 + 15 - 26| / \sqrt{25} = |1|/5 = \mathbf{1/5 = 0.2 \text{ units}}$.

Example 6

Find the distance between the parallel lines $3x - 4y + 7 = 0$ and $3x - 4y + 2 = 0$.

Answer: $d = |C_1 - C_2| / \sqrt{(A^2 + B^2)} = |7 - 2| / \sqrt{(3^2 + (-4)^2)} = 5/\sqrt{25} = 5/5 = \mathbf{1 \text{ unit}}$.

Example 7

Show that the points $(1, 4)$, $(3, -2)$ and $(-3, 16)$ are collinear.

Answer: Slope AB = $(-2 - 4)/(3 - 1) = -6/2 = -3$. Slope BC = $(16 - (-2))/(-3 - 3) = 18/(-6) = -3$. Since slope AB = slope BC, the points are **collinear**.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Find the slope of the line whose inclination with the x-axis is 60° .
2. What is the slope of a line parallel to the y-axis?
3. Write the slope of the line $2x - 3y + 5 = 0$.
4. If two lines are perpendicular and one has slope $\frac{3}{4}$, find the slope of the other.
5. Find the y-intercept of the line $4x + 5y - 20 = 0$.

2–3-Mark Questions (SA)

1. Find the equation of the line passing through $(-2, 3)$ and $(4, -1)$.
2. Find the angle between the lines $\sqrt{3}x + y = 1$ and $x + \sqrt{3}y = 1$.
3. Find the distance of the point $(4, 1)$ from the line $3x - 4y - 9 = 0$.
4. Reduce the equation $3x - 4y + 10 = 0$ to (i) slope-intercept form and (ii) intercept form.
5. Find the distance between the parallel lines $5x - 12y + 6 = 0$ and $5x - 12y - 7 = 0$.

5-Mark Questions (LA)

1. Derive the formula for the perpendicular distance of a point (x_1, y_1) from the line $Ax + By + C = 0$.
 2. Find the equation of the line passing through the intersection of the lines $x + 2y - 3 = 0$ and $2x - y + 1 = 0$ and parallel to the line $3x - y + 7 = 0$.
 3. Prove that three points are collinear using the slope condition, and verify with the area of the triangle being zero for the points $(2, 3)$, $(4, 7)$ and $(6, 11)$.
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Quick Revision Points

- Slope $m = \tan \theta = (y_2 - y_1)/(x_2 - x_1)$; horizontal line $m = 0$, vertical line m undefined
 - Parallel: $m_1 = m_2$; Perpendicular: $m_1 m_2 = -1$
 - Angle between lines: $\tan \theta = |(m_2 - m_1)/(1 + m_1 m_2)|$
 - Collinear if slope AB = slope BC, or area of triangle = 0
 - Point-slope: $y - y_1 = m(x - x_1)$; Two-point: use both points to get m first
 - Slope-intercept: $y = mx + c$; Intercept: $x/a + y/b = 1$
 - Normal form: $x \cos \omega + y \sin \omega = p$ ($p > 0$)
 - General form $Ax + By + C = 0$: slope = $-A/B$, x-intercept = $-C/A$, y-intercept = $-C/B$
 - Distance of a point from a line: $d = |Ax_1 + By_1 + C| / \sqrt{A^2 + B^2}$
 - Distance between parallel lines: $d = |C_1 - C_2| / \sqrt{A^2 + B^2}$
 - Family of lines through intersection: $L_1 + \lambda L_2 = 0$
-

Next Chapter: Chapter 10 — Conic Sections



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