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CHAPTER NOTES

Introduction to Euclid's Geometry Class 9 Notes | CBSE Maths

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Hi, I am **Ira**. I teach this syllabus all day, so **Introduction to Euclid's Geometry** is very much my home ground.

Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Introduction to Euclid's Geometry simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Introduction to Euclid's Geometry Class 9 Notes | CBSE Maths

Introduction to Euclid's Geometry: Axioms and Postulates is a chapter of CBSE Class 9 Maths (2026-27 syllabus). It tells the story of how geometry grew out of practical work in Egypt, India and Greece, walks through Baudhayana's rope-and-peg construction of a square from the Sulbasutras, and then sets out the base on which all of school geometry stands: Euclid's definitions, his axioms, his five postulates and the idea of parallel lines.

This chapter opens Unit IV, Geometry, which carries 25 marks in the 80-mark Class 9 paper and is shared with Lines and Angles, Triangles, Quadrilaterals and Circles. School exams test it through the statements of the axioms and postulates, naming the axiom behind a step, short proofs such as "two distinct lines meet in at most one point", the fifth postulate with angle sums, and the Sulbasutra construction. Later geometry proofs in Class 9 and Class 10 rely on the rules you learn here.

Quick Answer - Introduction to Euclid's Geometry

Geometry means "earth measurement". Nile floods, India to build planned cities turned it into a subject of proof. Around Today **point, line and plane** are taken as basic concepts (true across mathematics, such as "there is only one line through a point") (true in geometry, such as "a circle can be drawn with a given centre and radius"). Euclid proved everything else. His first postulate: outside a line, exactly one parallel can be drawn.



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All Key Formulas at a Glance

Idea	Rule or Result	Remember
Point between two points	$C \text{ between } A \text{ and } B \Rightarrow AC + CB = AB$	So $AC < AB$: the whole is greater than the part
Ray inside an angle	$OC \text{ inside } \angle AOB \Rightarrow \angle AOC + \angle COB = \angle AOB$	Angle version of the same rule
Midpoint	$C \text{ the midpoint of } AB \Rightarrow AC = CB = AB/2$	A segment has exactly one midpoint
Lines through two points	Exactly one line	Through one point: infinitely many
Two distinct lines	Meet in at most one point	Two lines in a plane are either parallel or intersect in a point
Lines through n points (no three on a line)	$n(n - 1)/2$	
Fifth postulate test	Interior angles on the same side of a transversal add up to $180^\circ \Rightarrow$ lines are parallel	
Playfair's axiom	Point P not on line l : there is exactly one line through P parallel to l	
Sulbasutra square of side a	Rope $a/2$ from each corner is enough to make a square	
Baudhayana's diagonal rule	$d^2 = l^2 + b^2$	



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Key Concepts

1. How Geometry Grew: Egypt, India and Greece

The word **geometry** comes from two Greek words: **geo**, meaning earth, and **metrein**, meaning to measure. So geometry literally means **earth measurement**.

Egypt. The traditional account, recorded by the Greek historian Herodotus, runs like this. Every year the river Nile flooded and washed away the stones that marked the boundaries between fields. After the water went down, officials had to measure the land again so that each family got back the same area. They did this with stretched ropes and pegs. Out of this work came practical rules for lengths, areas and right angles. The Egyptians also used geometry to build granaries and the pyramids.

India. The Harappan cities of the Indus Valley show careful planning: straight streets crossing at right angles, covered drains and houses with many rooms. Many of their fired bricks follow the ratio **length : breadth : thickness = 4 : 2 :**

Vedic period, the **Sulbasutras** (usually dated between 600 and 400 BCE, but scholars do not agree on exact dates) gave exact rules for measuring with a rope or rope. Altars had to have precise shapes and the texts give rules for changing one shape into another. The oldest of them.

Greece. The Greeks asked a new question: what always works? Later Greek writers credit Thales with the idea of bisected (cut into two equal halves) by its own writing survives. **Pythagoras** and his school. The Greek rule was that a statement is accepted only if it follows from statements already accepted.

Euclid and the Elements. Around 300 BCE, Euclid, who lived at Alexandria in Egypt, collected the geometric knowledge of his time into a book called the **Elements**. It is divided into **13 books**. He gave definitions, then listed a small number of assumptions and results already known, and then proved the rest.



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2. Constructing a Square by Baudhayana's Sulbasutra

Imagine you must lay out a square altar in an open field. You have no set square to check the corners and no protractor. You have a rope and some wooden pegs. The Sulbasutras show how to get four exact right angles with only these tools. The original text gives the method as short rules in Sanskrit. Below it is **rewritten in modern steps**, with letters for the points and the letter a for the side added to make it easy to follow.

1. **Fix a direction.** Draw the east-west line (the text calls it the **prachi**). Fix a peg at a point O on it. O will be the centre of the square.
2. **Mark two points on the prachi.** Take a rope of length $a/2$. Hold one end at O and mark points E and W on the prachi, one on each side, each at distance $a/2$ from O . Now $EW = a$.
3. **The fish figure.** Take a rope of length a , the full side. Fix one end at E and swing an arc. Do the same from W with the same rope. (Mathematically, any length greater than $a/2$ would also work.) The two arcs cross at two points, one to the north and one to the south. The overlapping arcs make a shape like a fish, so it is often called the fish figure. The line through the two crossing points is the **north-south** line. With the $a/2$ rope at O , mark the north-east corner. Repeat for the other three corners. Join the four corners.
4. **Find the corners.** With the $a/2$ rope, draw arcs from E and W . Besides O , they meet at a point that is the north-east corner. Repeat for the other three corners. Join the four corners.

Why it works. In step 3, each crossing point is the perpendicular bisector of EW (this fact is proved in the next chapter). So the north-south line cuts the prachi at O and is perpendicular to it. The distance from O to each corner is $a/2$ from the north-south line and $a/2$ from the prachi. So the distance from O to each corner is $a/2$. All four sides are a and all four angles are right angles.

For a square of side a : the rope from O to a corner is $a/\sqrt{2}$, and the diagonal is $a\sqrt{2}$.

Baudhayana's diagonal rule. In the usual construction, the diagonal of a rectangle produces by itself the squares on the length and the breadth put together. In modern words: the square of the diagonal is equal to the sum of the squares on the length and the breadth. For example, if the length is 3 and the breadth is 4, the square on the diagonal has area $9 + 16 = 25$, which is the square of 5. This is the Pythagoras theorem, stated in the Sulkasutra.



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3. Euclid's Definitions and Undefined Terms

Book 1 of the Elements opens with 23 definitions. The first few are:

1. A **point** is that which has no part.
2. A **line** is breadthless length.
3. The ends of a line are points.
4. A **straight line** is a line which lies evenly with the points on itself.
5. A **surface** is that which has length and breadth only.
6. The edges of a surface are lines.
7. A **plane surface** is a surface which lies evenly with the straight lines on itself.

For Euclid, "line" meant any line, straight or curved, and "the ends of a line" describes what we now call a **line segment**.

From solids down to points. Look at a closed figure in **three dimensions**. Its boundaries are its faces, which meet in **edges**, which are lines with one dimension. Each step down loses one dimension.

The problem with defining everything. Repeat the process. What part? In "a line is breadthless length", what are the new words, then more words to define those words. We agree to leave a few basic terms **undefined**. We have a clear intuitive sense of them: the tip of a needle suggests a point, a thread suggests a line, and the top of a screw suggests a true point has no size at all, and a true line

Defining new terms properly. Once the undefined terms are defined using terms already known. A **line segment** is the part of a line that starts at one point and ends at another. To define a square you first need polygon, since a square is a four-sided polygon with all sides equal and all angles equal.

Testing a definition. A good definition fits both directions. "A square is a quadrilateral with four equal sides and four equal angles." A quadrilateral with four equal sides and four equal angles is not a square. Test it.



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4. Euclid's Axioms (Common Notions)

An **axiom** is a statement accepted as true without proof. Euclid called his general assumptions **common notions**: statements that apply everywhere in mathematics, in geometry and beyond. Standard modern editions of the Elements list **five common notions** (numbers 1 to 5 below). Many school textbooks use a longer list of **seven axioms**, which adds numbers 6 and 7 about doubles and halves. This is the list schools commonly use, so the numbering below follows it:

1. Things which are equal to the same thing are equal to one another.
2. If equals are added to equals, the wholes are equal.
3. If equals are subtracted from equals, the remainders are equal.
4. Things which coincide with one another are equal to one another.
5. The whole is greater than the part.
6. Things which are double of the same things are equal to one another.
7. Things which are halves of the same thing are equal to one another.

The word "things" is general: it can mean points, lines, areas, etc. The axioms work in algebra as well as in geometry.

In symbols: axiom 1 says $a = c$ and $b = c \Rightarrow a = b$. Axiom 3 says $a = b \Rightarrow a - c = b - c$.

Axioms and postulates. Euclid used **postulates** as drawing a line through two points, and **axioms** as general assumptions used all over mathematics. The same idea.

Axioms in algebra. Solving $x - 7 = 12$ uses axiom 1. Results are equal and $x = 19$. If $2x = 2y$, then $x = y$ (axiom 7 in the school list).

Theorems. A statement that is proved using axioms and postulates is a **theorem** (the numbered result).

5. Axioms of Measurement: Length

Euclid's geometry was about comparing figures. These **axioms of measurement** say:



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- Every line segment has a **length**, which is a positive number.
- Every angle has a **measure** in degrees. A straight angle measures 180° and a right angle measures 90° .
- If a point C lies **between** A and B on a line, then **$AC + CB = AB$** .
- If a ray OC lies **inside** $\angle AOB$, then **$\angle AOC + \angle COB = \angle AOB$** .

These rules turn Euclid's words into numbers. Since CB is a positive number, $AC + CB = AB$ shows that $AC < AB$. That is axiom 5, "the whole is greater than the part", written with lengths.

Using the rules together. Points A, B, C and D lie on a line in that order with $AC = BD$. Then $AC = AB + BC$ and $BD = BC + CD$. So $AB + BC = BC + CD$ (axiom 1, both equal the same length). Subtracting the common part BC from both sides gives **$AB = CD$** (axiom 3). With $AC = BD = 11$ cm and $BC = 4$ cm, $AB = CD = 11 - 4 = 7$ cm.

The midpoint. C is the **midpoint** of AB if C lies on AB and $AC = CB$. Then $AC + CB = AB$ gives $AC + AC = AB$, that is, $2AC = AB$. So AC is half of AB. If C and D were both midpoints, then AC and AD would be equal (axiom 1). (This is not in the school list). Both C and D lie on AB on the

6. Euclid's Five Postulates

Euclid's **postulates** are the accepted rules that nobody proves. They speak about points,



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Postulate	Statement	In simple words
1	A straight line may be drawn from any one point to any other point.	Any two points can be joined.
2	A terminated line can be produced indefinitely.	A line segment can be extended as far as we like.
3	A circle can be drawn with any centre and any radius.	A compass can be set anywhere, open to any width.
4	All right angles are equal to one another.	Every right angle is the same size, wherever it is
5	If a straight line falling on two other straight lines makes the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.	



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A **terminated line** is a line segment, and **produced** means to extend a line segment. Postulate 2 is about drawing, which is why Euclid's construction of a circle is important. Postulate 4 fixes a standard angle.

Only one line through two points. Postulate 5 assumed there is only one such line. This is a **unique line that passes through them** and can be drawn.

A first theorem, by contradiction. *Theorem 4.1: Lines that do not intersect are parallel.* Suppose two different lines l and m would pass through the two distinct points P and Q . One line passes through two distinct points, so l and m meet in at most one point. This style of arguing something impossible, is called **proof by contradiction**.

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Counting lines. If n points are marked with no three on one line, each pair of points gives exactly one line, so the number of lines is the number of pairs: $\frac{n(n-1)}{2}$.

7. Justifying Simple Constructions with the Axioms

In earlier classes you learned constructions by following steps. In this chapter you also give a **reason for every step**: a postulate, an axiom or a definition. Euclid’s very first proposition shows how.

Euclid’s Proposition 1: an equilateral triangle on a given segment AB.

Step	What you do or claim	Reason
1	Draw a circle with centre A and radius AB.	Postulate 3
2	Draw a circle with centre B and radius BA.	
3	The circles meet at a point C. Join AC and CB.	
4	$AC = AB$	
5	$BC = AB$	
6	$AC = BC$	
7	$AB = BC = CA$, so triangle ABC is equilateral	

Euclid quietly assumed in step 3 that the two circles meet at a point. Later mathematicians noticed gaps like this and the modern course asks you to state every assumption.

The Sulbasutra square. As shown in construction, the four equal distances by the definition of a circle are equal. This is justified by postulate 4.



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8. Parallel Lines, the Fifth Postulate and Playfair's Axiom

Look along a straight railway track. The two rails stay the same distance apart and never meet, however far the track runs. In geometry, two lines in the same plane are **parallel** if they do not meet, however far they are produced in either direction. We write $l \parallel m$.

The fifth postulate in plain words. Draw two lines and a third line, the **transversal**, crossing both. At the two crossing points the transversal makes two **interior angles** (the angles between the two lines) on its left side and two on its right side. The fifth postulate says: if the two interior angles on one side add up to **less than 180°** (two right angles), the two lines lean towards each other on that side and, if produced far enough, **meet on that side**.

Working with the sums. At each crossing point the two angles on the transversal make a straight angle, 180° . So the four interior angles together make 360° .

- If the interior angles on one side add to 180° , the lines meet on the first side only.
- If the interior angles on one side add to 180° , the lines meet on the other side only.

Playfair's axiom. Because the fifth postulate is often used. It is named after the Scottish mathematician George Playfair. **every point P not lying on l, there exists a unique line m passing through P such that m is parallel to l.** Unique means exactly one: there is such a line and it is the only one. The fifth postulate and Playfair's axiom are **equivalent**: if you accept one, you can prove the other.

Results that follow.

- **Two distinct intersecting lines cannot be parallel to a third line.** If two lines intersect at P and both were parallel to l, then two lines would be parallel to l, which contradicts Playfair's axiom allows only one.
- **If a line cuts one of two parallel lines, it must cut the other.** If a line t does not meet m, then t and l would be two distinct lines parallel to l, which is impossible, so t must meet m.
- **Two lines parallel to the same line are parallel to each other.** If two lines m and n are both parallel to l, but they meet at a point, the first result would be contradicted. Therefore, if two lines are parallel to the same line, they are parallel to each other. **parallelism**, which you will meet again in Chapter 9.



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A two-thousand-year puzzle. Because the fifth postulate looked less obvious than the others, mathematicians tried for about two thousand years to prove it from the first four. Every attempt failed. In the nineteenth century mathematicians showed that you can replace it with a different assumption and still get a geometry with no contradictions. These are called **non-Euclidean geometries**. The surface of a sphere gives a related picture: there the “lines” are great circles (like the equator), any two of them meet, and there are no parallel lines at all. On a sphere some other rules change too, for example two great circles meet in two points.

Formula and Theorem Sheet

Name	Statement or formula
Axiom 1	Things equal to the same thing are equal to one another
Axiom 2	Equals
Axiom 3	Equals
Axiom 5	The wh
Axioms 6 and 7 (school list)	Double
Segment addition	C betw
Angle addition	OC insi
Postulate 1 with uniqueness	Exactly
Postulate 3	A circle
Postulate 4	All right
Postulate 5	Interior
Playfair’s axiom	Exactly
Counting lines	n points
Sulbasutra square	Rope a



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Important Definitions

- **Sulbasutras:** ancient Indian texts (usually dated to about 800 BCE to 500 BCE) giving rope-and-peg rules for building fire altars; sulba means cord or rope.
- **Undefined terms:** the basic ideas, point, line and plane, that are described but not formally defined.
- **Point (Euclid):** that which has no part.
- **Line (Euclid):** breadthless length.
- **Axiom:** a statement accepted without proof that is used throughout mathematics.
- **Postulate:** a statement accepted without proof that is specific to geometry.
- **Theorem (proposition):** a statement proved using definitions, axioms, postulates and earlier theorems.
- **Midpoint:** the point C on segment AB w
- **Parallel lines:** two lines in a plane that c direction.
- **Transversal:** a line that cuts two or mor
- **Interior angles:** the angles made by a t
- **Playfair's axiom:** through a point not on the given line.
- **Proof by contradiction:** a proof that ass leads to something impossible.
- **Non-Euclidean geometry:** a consistent different assumption.



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Solved Examples

Example 1: Harappan brick ratio

A Harappan brick has length, breadth and thickness in the ratio 4 : 3 : 1.
Find its breadth, thickness and volume.

Step 1: The length has 4 parts, so one part = $\frac{1}{4}$ of the length.

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Step 2: Breadth = $2 \times 6 = 12 \text{ cm}$. Thickness = $1 \times 6 = 6 \text{ cm}$.

Step 3: Volume = $24 \times 12 \times 6 = 1728 \text{ cm}^3$.

Example 2: Measurements in the Sulbasutra square

A square altar of side 8 m is laid out by Baudhayana's method with centre O. Find (a) the rope length used to mark E, W, N and S from O, (b) the distance from O to a corner, (c) the diagonal of the square.

(a) The rope is half the side: $8/2 = 4 \text{ m}$.

(b) A corner is 4 m east (or west) of the north-south line and 4 m north (or south) of the prachi. Distance from O = $\sqrt{4^2 + 4^2} = \sqrt{32} = 4\sqrt{2} \text{ m} \approx 5.66 \text{ m}$.

(c) The diagonal joins two opposite corners through O, so it is $2 \times 4\sqrt{2} = 8\sqrt{2} \text{ m} \approx 11.31 \text{ m}$. Check: $a\sqrt{2}$ with $a = 8$ gives the same.

Example 3: Baudhayana's diagonal

A rectangular altar is 12 m long and 5 m wide. Find the length of the diagonal and the length of the side of the square on its diagonal.

Step 1: Square on the length = $12^2 = 144 \text{ m}^2$

Step 2: By the rule, the square on the diagonal

Step 3: Diagonal = $\sqrt{169} = 13 \text{ m}$.

Example 4: Classifying statement

Classify each as an undefined term, a definition, an axiom, or a theorem.
(i) all right angles are equal to one another
(ii) distinct lines meet in at most one point, (if they meet)
(iii) points on it.

(i) **Undefined term**. (ii) **Postulate** (postulates are statements that are accepted as true across mathematics). (iv) **Theorem**, since it is a statement that can be proved built from the terms line and point.



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Example 5: Equal segments on a line

Points A, B, C and D lie on a line in that order and $AB = CD$. Prove that $AC = BD$.

Step 1: $AB = CD$ (given).

Step 2: Add BC to both sides: $AB + BC = CD + BC$ (axiom 2, equals added to equals).

Step 3: B lies between A and C, so $AB + BC = AC$. C lies between B and D, so $BC + CD = BD$.

Step 4: Substituting, **$AC = BD$** . $\therefore$ Proved.

Example 6: Every segment has one midpoint

C is the midpoint of AB. Prove that $AC = (1/2)AB$, and that AB has only one midpoint.

Step 1: C lies between A and B, so $AC + CB = AB$ (segment addition).

Step 2: $CB = AC$ (definition of midpoint), so

Step 3: Suppose D is another midpoint. Then

Step 4: AC and AD are both halves of AB, so the same distance from A coincide, so D is C.

Example 7: Finding part of an angle

Ray OC lies inside $\angle AOB$. $\angle AOB = 124^\circ$ and

Step 1: Let $\angle COB = x$. Then $\angle AOC = 3x$.

Step 2: Angle addition: $3x + x = 124^\circ$, so $4x = 124^\circ$.

Step 3: $\angle COB = 31^\circ$, $\angle AOC = 93^\circ$. Check: $93^\circ + 31^\circ = 124^\circ$.

Example 8: Counting lines through

(a) Five points are marked with no three collinear. How many lines can be drawn through two of them? (b) How many lines can be drawn through one of them?

(a) Each pair gives exactly one line (unique line through two points).



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(b) Through a single point, **infinitely many lines** can be drawn. Among the 10 lines above, 4 pass through any one marked point (one to each of the other four).

Example 9: Two lines meet in at most one point

Prove that two distinct lines cannot have more than one point in common.

Step 1: Let l and m be two distinct lines. Assume, if possible, that they have two distinct points P and Q in common.

Step 2: Then l passes through P and Q , and m also passes through P and Q .

Step 3: So two different lines pass through the two distinct points P and Q .

Step 4: This contradicts the axiom that exactly one line passes through two distinct points.

Step 5: So our assumption is false. $\therefore$ Two distinct lines cannot have more than one point in common.

Example 10: Equilateral triangle with side length 5 cm

Given a segment AB of length 5 cm, construct an equilateral triangle ABC .

Step 1: With centre A and radius $AB = 5$ cm, draw a circle.

Step 2: With centre B and radius $BA = 5$ cm, draw another circle.

Step 3: Let the circles meet at C . Join CA and CB .

Step 4: $AC = AB = 5$ cm (radii of the first circle).

Step 5: $AC = BC$ (axiom 1). So $AB = BC = CA$. $\therefore ABC$ is an equilateral triangle.

Example 11: Using the fifth postulate

A transversal cuts two lines. On one side of the transversal, the interior angles are $3x$ and 150° . (a) If $x = 50^\circ$, are the lines parallel? (b) If $x = 60^\circ$, are the lines parallel?

(a) The lines are parallel when the interior angles are supplementary. $3x + 150^\circ = 180^\circ$. $3x = 180^\circ - 150^\circ$. $3x = 30^\circ$. $x = 10^\circ$. $\therefore$ The lines are not parallel.



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Hi, I am [Ira](#). I teach this syllabus all day, so [Introduction to Euclid's Geometry](#) is very much my home ground.

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(b) With $x = 45^\circ$, the sum is $45^\circ + 120^\circ = 165^\circ$, which is less than 180° . By the fifth postulate the lines **meet on this side**. The other side sums to $360^\circ - 165^\circ = 195^\circ$.

Competency-Based Questions (with answers)

1. Case-based: Re-marking the fields

After a flood, a village surveyor has three boundary stones P, Q and R that he knows lie on one straight boundary. With a knotted rope he measures $PQ = 18\text{ m}$, $QR = 27\text{ m}$ and $PR = 45\text{ m}$.

(a) Which stone lies between the other two? Justify. $PQ + QR = 18 + 27 = 45 = PR$. So **Q lies between P and R**, by segment addition.

(b) He places a new stone M exactly halfway between P and R. Find PM and QM. $PM = 45/2 = 22.5\text{ m}$. Q is 18 m from P, so $QM = 22.5 - 18 = 4.5\text{ m}$.

(c) Which axiom tells us there is only one line passing through two points?

at half of PR from P, so their distances from P are equal (this is the same thing as saying the same thing are equal). Both lie on PR (by the previous part).

2. Case-based: The altar builders

Priests must lay out a square altar of side length 3 m with a centre peg O.

(a) What rope length do they use to mark the corners?

(b) In the fish figure, why does the line through the eyes make equal angles to the prachi? Both arcs use the same centre (the midpoint of EW). Points equally far from E and W lie on the perpendicular bisector of EW.

(c) How far is each corner from O? $\sqrt{3^2 + 3^2} = 3\sqrt{2}\text{ m}$.

3. Source-based: Euclid's first definition

"A point is that which has no part. A line is that which has length and breadth only. The end of a line is a point. A surface is that which has length and breadth."



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(a) Name the undefined words these definitions depend on. Part, breadth and length (and “evenly” in the definition of a straight line).

(b) Why do modern mathematicians take point, line and plane as undefined? Defining them needs other words, which need further definitions, and the chain never ends. So we start from a few terms understood intuitively.

(c) For a cube, name one object of each dimension 0, 1 and 2. Corner (0), edge (1), face (2).

4. Assertion-Reason

Assertion (A): If $a + b = 10$ and $a + c = 10$, then $b = c$. **Reason (R):** Things which are equal to the same thing are equal to one another, and if equals are subtracted from equals, the remainders are equal.

Answer: (a) Both A and R are true, and R is the correct explanation of A. $a + b = a + c$ (axiom 1), then subtract a from both sides (axiom 3).

5. Assertion-Reason

Assertion (A): Through a point P not on a

Reason (R): Through any point, infinitely n

Answer: (b) Both A and R are true, but R is R is true, but it says nothing about which c

6. Assertion-Reason

Assertion (A): Two distinct lines can meet through two distinct points.

Answer: (d) A is false, but R is true. R is ex

7. Reasoning: Do the roads meet?

Two straight roads are crossed by a straight canal. The angles between the canal and the roads are

(a) Will the roads meet if extended? On which side? postulate the roads **meet on the northern**

(b) What is the sum on the southern side? $360^\circ - 177^\circ = 183^\circ$.



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(c) By how much must the 94° angle change (the other fixed) for the roads to be parallel? The sum must be 180° , so 94° must become 97° , an increase of 3° .

8. Source-based: Geometry on a globe

On a globe, the "straight lines" are great circles such as the equator and the lines of longitude. Every two great circles meet.

(a) Which parallel-line rule fails on the globe? Playfair's axiom: through a point outside a given great circle, no great circle can be drawn that never meets it, so there are no parallels at all.

(b) Two lines of longitude both meet the equator at right angles. Do they meet each other?

Yes, at the North Pole and the South Pole. On a flat plane, two lines both perpendicular to one line never meet. They also meet in two points, which breaks the plane rule that two distinct lines meet in at most one point. So the globe does not follow Euclid's geometry.

Important Questions for

1-Mark Questions

1. What does the word geometry literally measure).
2. How many books does Euclid's Elements consist of?
3. How many lines can pass through two points?
4. Write Euclid's fourth postulate. All right angles are equal.
5. Name the three undefined terms of geometry.

2-Mark Questions

1. Differentiate between an axiom and a postulate. Axioms (common notions) are used throughout geometry, while postulates are specific to geometry. Axioms are "greater than the part", while postulates are "drawn with any centre and any radius".
2. Two friends have equal savings. Each friend has a certain amount of money. If one friend has $a + 500$ and the other has $b + 500$, and they are equal, find the value of a and b .



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3. **State Playfair's axiom.** For every line l and every point P not lying on l , there exists a unique line m passing through P and parallel to l .
4. **C lies between A and B , $AB = 15$ cm and $AC = 6$ cm. Find CB and state the result used.** $AC + CB = AB$ (segment addition), so $CB = 15 - 6 = 9$ cm.

3-Mark Questions

1. **Prove that two distinct lines cannot have more than one point in common.** Suppose distinct lines l and m share two distinct points P and Q . Then two different lines pass through P and Q . This contradicts the axiom that only one line passes through two distinct points. So the supposition is false, and two distinct lines have at most one common point.
2. **Points A, B, C, D lie on a line in that order and $AC = BD$. Prove $AB = CD$.** $AC = AB + BC$ and $BD = BC + CD$. Since $AC = BD$, $AB + BC = BC + CD$ (axiom 1). Subtracting BC from both sides, $AB = CD$ (axiom 3).
3. **A transversal makes interior angles $2x - 10^\circ$ and $x + 40^\circ$ on one side of it. Find x if the two lines are parallel. For $x = 40^\circ$, state whether the lines are parallel or not.** For $x = 40^\circ$: $70^\circ + 80^\circ = 150^\circ < 180^\circ$. The lines are not parallel.
4. **Describe how the Sulbasutra method of finding the perpendicular bisector of a line segment AB works.** Take two points O and W on the east-west line at equal distances from A and B respectively. Take a rope of the same rope length (longer than OE). The rope is stretched tight between O and W . The line through them is the perpendicular bisector of AB at a right angle.



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5-Mark Questions

1. **State Euclid's five postulates. Which of them lead to new geometries?** (1) A straight line can be drawn through any two points. (2) A terminated line can be produced in both directions. (3) A circle can be drawn with any centre and any radius. (4) All right angles are equal to one another. (5) If two straight lines are intersected by a transversal such that the sum of interior angles on one side is less than two right angles, then the two straight lines will intersect on that side. The fifth postulate, which the sum of angles is less than two right angles, happens far away, so it looked less obvious. It took centuries to prove it from the first four and another assumption gave consistent non-Euclidean geometry. A sphere, where no parallels exist, is a related example.

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2. **Construct an equilateral triangle on a given segment AB (Euclid's Proposition 1), giving the postulate, axiom or definition behind every step. Point out one assumption Euclid used without stating it.** Draw a circle with centre A and radius AB (postulate 3). Draw a circle with centre B and radius BA (postulate 3). Let them meet at C and join CA, CB (postulate 1). $AC = AB$ and $BC = AB$ (radii of the same circle, by the definition of a circle). $AC = BC$ (axiom 1). So $AB = BC = CA$ and triangle ABC is equilateral. Unstated assumption: that the two circles actually meet at a point C; none of Euclid's postulates guarantees it.

Common Mistakes and Examiner Tips

1. **Mixing up axioms and postulates.** Axioms are used across mathematics; postulates are about geometry. "All right angles are equal" is a postulate, and "the whole is greater than the part" is an axiom.
2. **Giving the wrong postulate number.** Memorise the order: 1 joins two points, 2 extends a segment, 3 draws a circle, 4 equal right angles. Remember the postulate number as well as the number.
3. **Saying infinitely many lines pass through two distinct points.** Infinitely many pass through a point.
4. **Citing axiom 2 when you subtracted.** For subtraction, use axiom 1. Check which operation you actually did.
5. **Citing a postulate for $AC = BC$ in Proposition 1.** The postulates only draw the circles.
6. **Comparing the angle sum with 90° or 180° .** Angles on one side with 180° (two right angles).
7. **Choosing the wrong side in the fifth postulate.** Angles less than 180° . They never meet on the other side.
8. **Treating undefined terms as a weakness.** Treat them as the starting blocks. Say this clearly in your answer.
9. **Using the full side as the radius in the construction.** The radius is $a/2$, half the side. The centre-to-corner distance is $a/2$.
10. **Leaving out "distinct" or "not on the line".** Playfair's axiom needs P not on l. Euclid's postulate 1 needs distinct points.



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Quick Revision Points

- Geometry = geo (earth) + metrein (measure): earth measurement.
- Sulbasutras (usually dated about 800 BCE to 500 BCE): rope-and-peg rules for fire altars; sulba = cord or rope.
- Baudhayana's Sulbasutra is generally regarded as the oldest; it states the diagonal rule $d^2 = l^2 + b^2$.
- Sulbasutra square of side a : prachi, centre O , rope $a/2$, fish figure for the north-south line, corner arcs of radius $a/2$.
- Centre to corner = $a/\sqrt{2}$; diagonal = $a\sqrt{2}$.
- Euclid, believed to have taught at Alexandria, about 300 BCE: the Elements in 13 books; Book 1 has 23 definitions.
- Undefined terms: point, line, plane.
- Axioms (Euclid's common notions, five in geometry) are the foundation of geometry across mathematics. Postulates: specific axioms for geometry.
- Axiom 1: equal to the same thing $\Rightarrow$ equal to each other. If two things are equal to the same thing, they are equal to each other.
- C between A and $B \Rightarrow AC + CB = AB$; O on the line segment $AB \Rightarrow AO + OB = AB$.
- Postulates: join two points; extend a segment; draw a circle with any centre and radius; $180^\circ \Rightarrow$ lines meet on that side.
- Exactly one line through two distinct points.
- Two distinct lines meet in at most one point.
- n points, no three on a line: $n(n - 1)/2$ lines.
- Interior angles on one side = $180^\circ \Rightarrow$ lines are parallel.
- Playfair's axiom: exactly one parallel line through a point not on a given line.
- A line cutting one of two parallels cuts the other parallel.



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Weightage and Exam Pattern

Class 9 has no board exam. This chapter is included in the half-yearly exam and the annual exam.

For 2026-27, the chapter sits in **Unit IV, Geometry, which carries 25 marks** out of the 80-mark

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theory paper. The unit also contains Lines and Angles, Triangles (congruence theorems), 4-gons (quadrilaterals) and Circles, and the course structure allots 69 teaching periods to the unit as a whole. It does not give a separate mark figure for this chapter. The remaining 20 marks are internal assessment (pen-paper tests and multiple assessment 10, portfolio 5, lab practical 5).

Unit	Marks (out of 80)
I. Number System	07
II. Algebra	20
III. Coordinate Geometry	04
IV. Geometry	25
V. Mensuration	14
VI. Statistics and Probability	

The CBSE question paper design weights understanding, 24% applying, and 22% an

The course structure lists the key concept construction of a square, Euclid’s definitio geometric objects, with the five postulates chapters of the Geometry unit use these a foundation for the rest of the unit.



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