

**CHAPTER TEST: INTRODUCTION TO EUCLID'S GEOMETRY**

Mathematics | Class IX (2026/EUCLID/09/LongAns/002)

Time: 1 Hour

Max. Marks: 25

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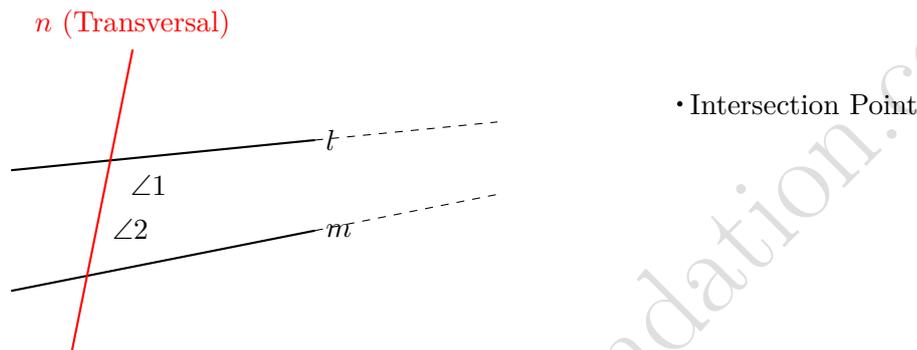
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**LONG ANSWER QUESTIONS: EUCLID'S GEOMETRY**  
**SET – 2 (The Fifth Postulate and its Equivalents)**

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**Q1. Euclid's Fifth Postulate:** If a straight line falling on two straight lines makes the interior angles on the same side of it taken together less than two right angles ( $180^\circ$ ), then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.

**Illustration:**



In the diagram, if  $\angle 1 + \angle 2 < 180^\circ$ , lines  $l$  and  $m$  will eventually intersect on the right side.

**Q2. Playfair's Axiom:** For every line  $l$  and for every point  $P$  not lying on  $l$ , there exists a unique line  $m$  passing through  $P$  and parallel to  $l$ .

**Equivalence:** Euclid's 5th postulate implies that if the sum of angles is *exactly*  $180^\circ$ , the lines will never meet (parallel). Playfair's Axiom simplifies this by stating only *one* such parallel line can exist through a specific point. Both statements lead to the same logical conclusion regarding the nature of parallel lines in a flat plane.

**Mathematical Quest:** Mathematicians tried to prove the 5th postulate because it was much more complex than the other four. They believed it was a theorem that could be derived from the simpler postulates 1–4. This quest eventually led to the discovery of Non-Euclidean geometries.

**Q3. Proof:**

- Let  $l, m,$  and  $n$  be three lines. Let  $l$  and  $m$  be two distinct intersecting lines.
- Suppose both  $l$  and  $m$  are parallel to line  $n$ .
- Let the point of intersection of  $l$  and  $m$  be  $P$ .
- This means that through a point  $P$  (not on line  $n$ ), there are **two** distinct lines ( $l$  and  $m$ ) parallel to line  $n$ .
- However, this directly contradicts **Playfair's Axiom**, which states that through a point not on a line, there is only **one unique** line parallel to the given line.
- Therefore, our assumption is wrong. **Conclusion:** Two distinct intersecting lines cannot be parallel to the same line.

**Q4. Analysis of Postulates:**

- (i) **Undefined Terms:** Both postulates contain undefined terms such as 'point', 'line', and 'in between'.

(ii) **Consistency:** Yes, they are consistent. They do not contradict each other; it is possible for a point to exist between two others while also having a third point not on that same line.

(iii) **Derivation from Euclid:**

- Postulate (i) is a consequence of the fact that lines are continuous and infinitely divisible (related to Postulate 2).
- Postulate (ii) is an independent assumption that defines the existence of a 2D plane. Euclid assumes this implicitly in his constructions (like the equilateral triangle), but it is not explicitly stated in his original five postulates.

**Q5. Consistency in Axioms:** A system of axioms is said to be **consistent** if it is impossible to derive a contradiction from them. If a system is inconsistent, any statement (both true and false) could be proven, making the system mathematically useless.

**Contradiction Example:** If we added a postulate saying "Two parallel lines eventually meet," it would contradict the definition of parallel lines in Euclidean geometry.

**Historical Context:** For centuries, mathematicians tried to replace Euclid's 5th Postulate. By assuming the 5th Postulate was *false* (e.g., assuming multiple parallel lines or no parallel lines exist), they didn't find a contradiction. Instead, they discovered **Non-Euclidean Geometries** (like Hyperbolic and Elliptic geometry). This proved that Euclid's system was consistent but not the *only* possible geometric system.