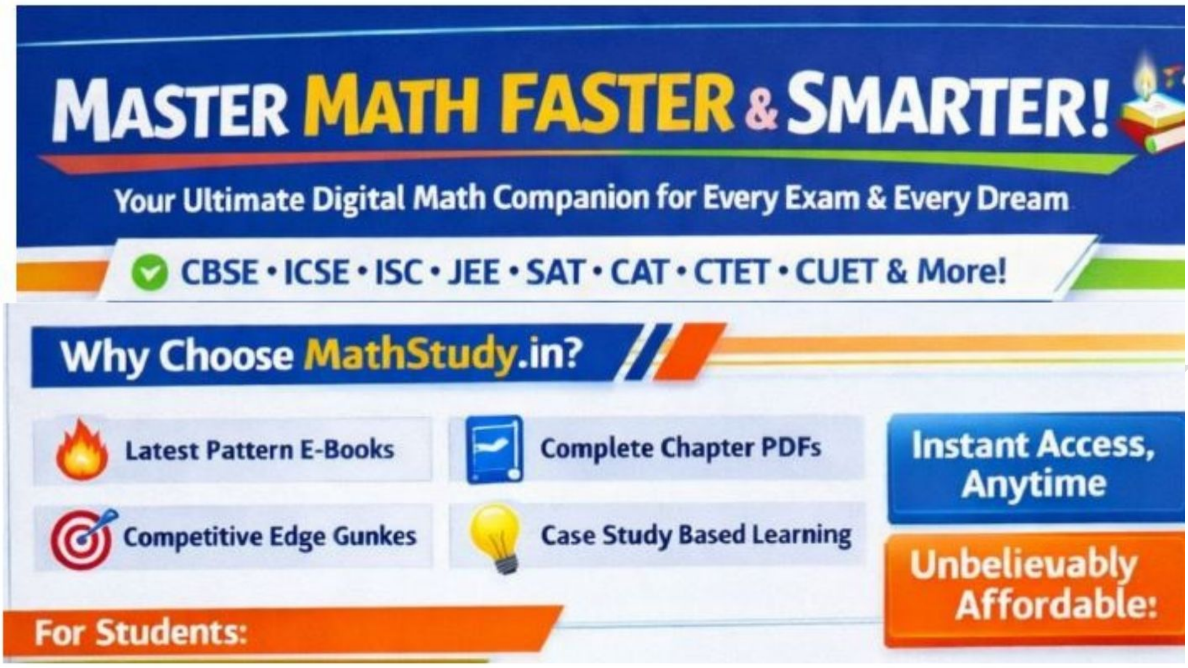
SOLUTIONS



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SOLUTIONS: INTRODUCTION TO EUCLID'S GEOMETRY

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

Section A (Multiple Choice Questions)

1. **(b) Things which are halves of the same things are equal.** Since $AC + BC = AB$ and $AC = BC$, then $2AC = AB$, so AC is half of AB.
2. **(b) Substitution based on Euclid's 1st Axiom.** Since $x = z$, z can replace x because things equal to the same thing are equal.
3. **(c) Only one.** Euclid's Postulate 1 combined with the axiom of uniqueness states there is a unique line passing through two distinct points.
4. **(b) Axiom 5.** This is a common notion (axiom) indicating that a part is always smaller than its whole.
5. **(c) Any polygon.** The base of a pyramid can be a triangle, square, pentagon, etc.
6. **(a) Things which coincide with one another are equal.** Euclid uses the idea of superposition to show that LM and MN together coincide with LN.
7. **(a) Axiom 6.** Things which are double of the same things are equal to one another.
8. **(b) 9.** The Sri Yantra consists of nine interwoven isosceles triangles.

Section B (Very Short Answer Questions)

1. Given $a < b$ on a line. Between any two points on a line, there are infinitely many points. This relates to the **Continuity** of a line, where a line is an undefined term representing a collection of points that extends infinitely in both directions.
2. $u - 15 = 25$. Adding 15 to both sides: $u - 15 + 15 = 25 + 15 \implies \mathbf{u = 40}$.
   Axiom used: If equals are added to equals, the wholes are equal (Axiom 2).
3. Given $AB = BC$ and $BX = BY$.
   According to Euclid's Axiom 3: "If equals are subtracted from equals, the remainders are equal."
   Subtract BX from AB and BY from BC:
   $AB - BX = BC - BY \implies \mathbf{AX = CY}$.
4. **Parallel Lines:** Lines in the same plane that never intersect, no matter how far they are produced.
   Terms to be defined first: Plane, Line, Point, and Intersection.

Section C (Short Answer Questions)

1. **Proof:**

   Consider line segment AB. Point C lies between A and B.
   $AC + CB = AB$ (Since AC and CB coincide with AB).
   Given $AC = BC$.

Substituting BC with AC:
$AC + AC = AB \implies 2AC = AB$.
Dividing by 2 (Axiom 7: halves of equals are equal): $\mathbf{AC = \frac{1}{2}AB}$.

2. Given: $\angle 1 = \angle 2$ and $\angle 2 = \angle 3$.
   Axiom 1: "Things which are equal to the same thing are equal to one another."
   Since both $\angle 1$ and $\angle 3$ are equal to $\angle 2$, it follows that $\angle 1 = \angle 3$.

3. Since B lies between A and C, the segment AB and BC together exactly cover AC. In Euclid's logic, $AB + BC$ **coincides** with AC.
   Axiom 4: "Things which coincide with one another are equal to one another."
   Therefore, $AB + BC = AC$.

Section D (Long Answer Questions)

1. (i) **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.
   (ii) It is equivalent because if the sum of interior angles were less than 180°, Euclid's 5th Postulate says they would meet. Playfair's axiom defines the unique case where they *never* meet.
   (iii) **No.** Euclid's geometry is plane geometry. On a sphere, the shortest distance is a curve (Great Circle), and the sum of angles in a triangle is greater than 180°.

2. **Proof:**

   Given: $AB = CD$.
   Point C lies between A and B, so $AC + CB = AB$.
   Point B lies between C and D, so $CB + BD = CD$.
   Since $AB = CD$, we have:
   $AC + CB = CB + BD$.
   Using **Axiom 3** (Subtracting equals from equals):
   Subtract CB from both sides:
   $(AC + CB) - CB = (CB + BD) - CB$.
   $\mathbf{AC = BD}$. **Hence Proved.**

Section E (Case Study Based Question)

1. **(a) Axiom 4.** The total length is the sum of its parts that coincide with it.

2. **(b) Axiom 1.** Things equal to the same thing ($5cm$) are equal to each other.

3. **(b) Axiom 3.** If equals are subtracted from equals, the remainders are equal.

4. **(c) A Plane Surface.** A flat metal plate represents Euclid's 2D plane.

5. **(d) Three dimensions.** Any real-world object (solid) has length, breadth, and thickness.