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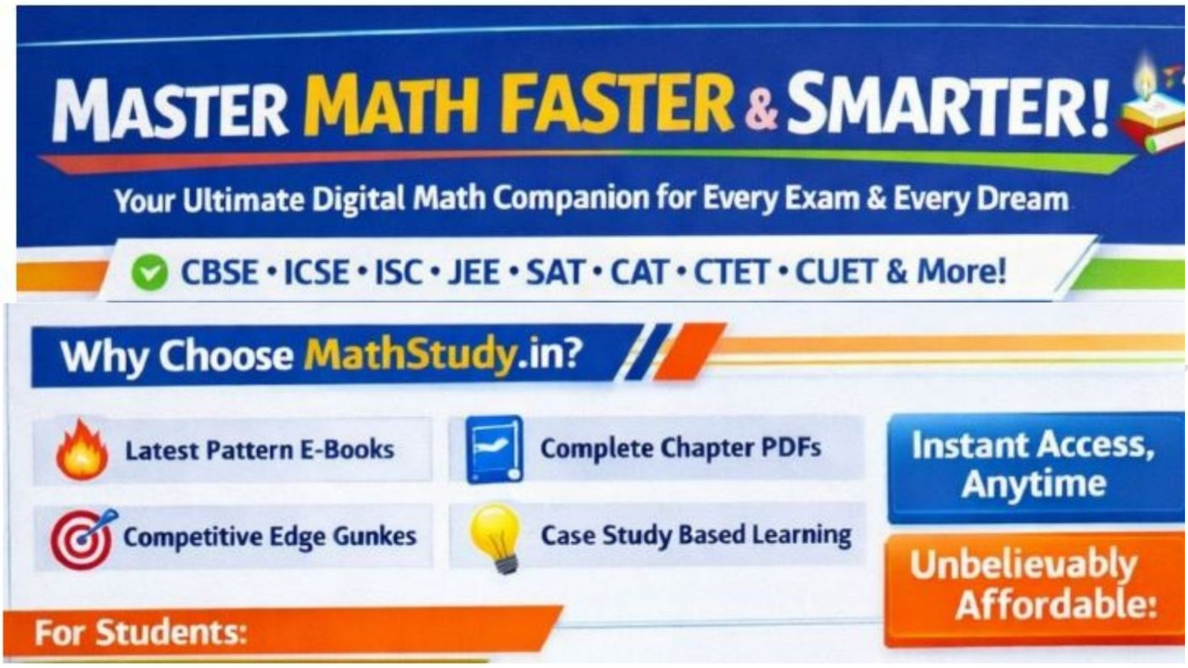

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SOLUTIONS: EUCLID'S GEOMETRY (HOTS)

Mathematics | Class IX | (2026/EUCLID-HOTS/09/001)

Section A: Multiple Choice Questions

1. **(c) $\frac{n(n-1)}{2}$.** From n points, we can choose any 2 to form a unique line. This is given by the combination formula ${}^nC_2$.
2. **(b) For every line l and point P not on l, there exists a unique line m through P parallel to l.** This is the most common equivalent form of the 5th postulate.
3. **(c) Are parallel.** If the sum is exactly 180°, they never meet, satisfying the definition of parallel lines.
4. **(a) Magnitudes of same kind.** You can add lines to lines or angles to angles, but you cannot add a line to an angle.
5. **(c) Greater than 180°.** In spherical geometry, lines (Great Circles) curve toward each other, increasing the internal angles.
6. **(c) Both (a) and (b).** Euclid's system assumes that such a point exists on the segment and that there is only one such point.
7. **(a) It uses undefined terms like "very long".** Definitions must be precise; "very long" is relative and subjective.
8. **(c) Lines.** A 3D solid is bounded by 2D surfaces, and a 2D surface is bounded by 1D lines.

Section B: Very Short Answer Questions

1. **Proof:** Since B lies between A and C, AB is a "part" of the "whole" AC.
   According to **Axiom 5**: "The whole is greater than the part," therefore $AC > AB$.
2. **Answer:** Postulates 1–4 are simple, intuitive, and easy to visualize. Postulate 5 is long, looks like a theorem that requires proof, and involves a complex condition about the sum of interior angles.
3. **Proof:** Since L is on MN, $ML + LN = MN$ (Axiom 4). Since K is on LN, $LK + KN = LN$.
   Substituting LN: $ML + (LK + KN) = MN$.
   Since $(ML + LK)$ coincides with MK, we have $\mathbf{MK} + \mathbf{KN} = \mathbf{MN}$.
4. **Answer:** $x - 10 = 15$.
   Add 10 to both sides: $x - 10 + 10 = 15 + 10 \implies \mathbf{x = 25}$.
   Axiom 2: If equals are added to equals, the wholes are equal.

Section C: Short Answer Questions

1. **Proof by Contradiction:** Suppose two distinct lines l and m intersect at *two* points, P and Q.
   This implies that through two distinct points P and Q, there are two different lines.
   However, this contradicts Euclid's **Postulate 1** (and its subsequent axiom) which states that through two distinct points, there is one and only one unique line.
   Hence, our assumption is false. Two distinct lines can have at most one point in common.

2. **Proof:** Given $QX = RY$ and $PX = PY$.
According to **Axiom 2**: "If equals are added to equals, the wholes are equal."
Adding the given equations: $PX + QX = PY + RY$.
From the figure, $PX + QX = PQ$ and $PY + RY = PR$.
Therefore, $\mathbf{PQ} = \mathbf{PR}$.

3. **Definitions:**
   - **Perpendicular Lines:** Two lines which intersect each other at a right angle (90°).
   - **Square:** A quadrilateral with all four sides equal and all four angles being right angles.
   - **Pre-defined terms:** Point, Line, Angle, Right Angle, Quadrilateral, Intersection.

Section D: Long Answer / HOTS Questions

1. **Analysis:** (i) It is often treated as an **Axiom** (derived from Postulate 1).
(ii) In Euclidean geometry, lines are flat. On a sphere, "lines" are Great Circles. Two distinct points (like the North and South Poles) can have infinitely many Great Circles (lines) passing through them.
(iii) [Diagram: A sphere with multiple longitudinal lines meeting at the poles].

2. **Axiomatic Steps:** 1. Draw line segment AB.
2. Draw circle with center A and radius AB (**Postulate 3**).
3. Draw circle with center B and radius BA (**Postulate 3**).
4. Let intersection be C. Join AC and BC (**Postulate 1**).
5. $AB = AC$ (Radii of same circle). $AB = BC$ (Radii of same circle).
6. $AC = BC$ (**Axiom 1**: Things equal to the same thing are equal).
7. Hence $AB = BC = AC$ ($\triangle ABC$ is equilateral).

3. **Advanced Discussion:** Both statements are **equivalent** to Euclid's Fifth Postulate.
If we assume (1) or (2) is false, we enter the realm of **Non-Euclidean Geometries**. For example, in Hyperbolic geometry, the sum of angles in a triangle is $< 180°$, and parallel lines are not equidistant. These logical variations prove that the Fifth Postulate is independent and cannot be proven using the first four postulates.