SOLUTIONS

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SOLUTIONS: INTRODUCTION TO EUCLID'S GEOMETRY

Section A: Multiple Choice Questions

1. **(c) Length and breadth only.** According to Euclid's definitions, a surface has two dimensions.

2. **(c) 3.** A solid has three dimensions: length, breadth, and thickness (depth).

3. **(a) Universal truths in all branches of mathematics.** Axioms are assumptions not specific to geometry alone.

4. **(b) Euclid's Axiom.** This is the third axiom listed in Euclid's Elements.

5. **(b) 5.** Euclid gave five specific geometric postulates.

Section B: Short Answer Questions

6. **Postulate 1:** A straight line may be drawn from any one point to any other point.
   Postulate 3: A circle can be drawn with any center and any radius.

7. **Proof:**
   Given that point C lies between A and B, such that $AC = BC$.
   We know that $AC + BC = AB$ (Since AC and BC coincide with AB).
   Given $AC = BC$.
   Substitute BC with AC in the equation:
   $AC + AC = AB \implies 2AC = AB$.
   Therefore, $\mathbf{AC = \frac{1}{2}AB}$. **Hence proved.**

8. **(a) Parallel lines:** Lines in the same plane that never intersect, no matter how far they are produced.
   (b) Line segment: A part of a line with two distinct endpoints.

9. **Axiom 1:** "Things which are equal to the same thing are equal to one another."
   Since x is equal to y (implied by the sum) and x is equal to z, then z can replace x in the equation.

Section C: Long Answer Questions

10. **Construction of Equilateral Triangle:**
    1. Let AB be the given line segment.
    2. Using Postulate 3, draw a circle with center A and radius AB.
    3. Draw another circle with center B and radius BA.
    4. Let the circles intersect at point C. Join AC and BC.
    5. Now, $AB = AC$ (radii of the same circle) and $AB = BC$ (radii of the same circle).
    6. By Axiom 1, $AC = BC$. Therefore, $AB = BC = AC$. Thus, $\triangle ABC$ is equilateral.

11. **Proof:**
    Given $AC = BD$.
    From the figure, $AC = AB + BC$ and $BD = BC + CD$.
    So, $AB + BC = BC + CD$.

Subtracting BC from both sides (Axiom 3: "If equals are subtracted from equals, the remainders are equal"), we get:
$AB + BC - BC = BC + CD - BC \implies$ **AB = CD**. **Hence proved.**

12. **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°), then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.

13. **Explanation:** Yes, this is an equivalent version of the 5th Postulate (Playfair's Axiom). If the distance between two lines is always the same, they never meet. Euclid's 5th postulate implies that lines only meet if the sum of interior angles is $< 180°$; if the sum is exactly 180°, they are equidistant and parallel.

Section D: Concept Checklist

1. A line has **breadthless** length.

2. The boundaries of a surface are **lines**.

3. Playfair's Axiom is an equivalent version of Euclid's **Fifth** Postulate.

4. The edges of a surface are **lines**.