NCERT Solutions Class 9 Maths
Chapter 5: Introduction to Euclid's Geometry
EXERCISE 5.1

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Quick Summary: In NCERT Solutions Class 9 Maths Chapter 5 Exercise 5.1, students learn the fundamental concepts of Euclidean geometry through Euclid's definitions, axioms, and postulates. This exercise covers the logical foundation of geometry including proof techniques and the analysis of geometric statements, which are essential for building strong reasoning skills required in CBSE board exams and competitive mathematics.

Key Takeaways:

- Understanding Euclid's five postulates and their role in defining geometric relationships
- Mastering Euclid's axioms, particularly "If equals are added to equals, the wholes are equal"
- Learning proof by contradiction technique to prove uniqueness (like proving a line segment has only one midpoint)
- Analyzing geometric statements for consistency and identifying undefined terms in postulates

Complete Solutions

Question 1

QUESTION

Which of the following statements are true and which are false? Give reasons for your answers:

(i) Only one line can pass through a single point.
(ii) There are an infinite number of lines which pass through two distinct points.
(iii) A terminated line can be produced indefinitely on both sides.
(iv) If two circles are equal, then their radii are equal.
(v) In Fig. 5.9, if AB = PQ and PQ = XY, then AB = XY.

SOLUTION

This question tests our understanding of Euclid's postulates and axioms. We need to determine the truthfulness of each statement and provide a valid reason.

(i) False.

Step 1: Visualize the statement

Imagine a single point on a piece of paper. Now, try drawing lines passing through that point. You can draw lines in many different directions.

Step 2: Explain why the statement is false

It is possible to draw an infinite number of lines through a single point. Each line can have a different slope or orientation while still passing through the same point.

Final Answer: False. This can be seen visually.

(ii) False.

Step 1: Recall Euclid's Axiom 5.1

Euclid's Axiom 5.1 states: "Given two distinct points, there is a unique line that passes through them."

Step 2: Explain the contradiction

The given statement claims that an infinite number of lines can pass through two distinct points. This directly contradicts Euclid's first axiom, which asserts that only one unique line can pass through two distinct points.

Final Answer: False. This contradicts Axiom 5.1.

(iii) True.

Step 1: Recall Euclid's Postulate 2

Euclid's second postulate states: "A terminated line can be produced indefinitely."

Step 2: Relate the postulate to the statement

The given statement is a direct rephrasing of Euclid's second postulate. A terminated line is simply a line segment, and the postulate allows us to extend it infinitely in both directions to form a line.

Final Answer: True. (Postulate 2)

(iv) True.

Step 1: Understand the meaning of equal circles

If two circles are equal, it means they have the same size and shape. In other words, they are congruent.

Step 2: Superimpose the circles

Imagine placing one circle exactly on top of the other. Since they are equal, the region bounded by one circle will perfectly coincide with the region bounded by the other.

Step 3: Deduce the equality of radii

If the circles coincide perfectly, their centers must also coincide. Furthermore, their boundaries must coincide as well. This implies that the distance from the center to any point on the boundary (i.e., the radius) must be the same for both circles.

Final Answer: True. If you superimpose the region bounded by one circle on the other, then they coincide. So, their centres and boundaries coincide. Therefore, their radii coincide.

(v) True.

Step 1: Recall Euclid's first axiom

Euclid's first axiom states: "Things which are equal to the same thing are equal to one another."

Step 2: Apply the axiom to the given information

We are given that and . This means that both and are equal to the same thing, which is .

Step 3: Conclude based on the axiom

According to Euclid's first axiom, since and are both equal to , they must be equal to each other. Therefore, .

Final Answer: True. The first axiom of Euclid.

ANSWER

(i) False. This can be seen visually by the student.

(ii) False. This contradicts Axiom 5.1.

(iii) True. (Postulate 2)

(iv) True. If you superimpose the region bounded by one circle on the other, then they coincide. So, their centres and boundaries coincide. Therefore, their radii coincide.

(v) True. The first axiom of Euclid.

Question 2

QUESTION

Give a definition for each of the following terms. Are there other terms that need to be defined first? What are they, and how might you define them?

(i) parallel lines
(ii) perpendicular lines
(iii) line segment
(iv) radius of a circle
(v) square

SOLUTION

This question tests our understanding of basic geometric definitions and the need for prior definitions in Euclidean geometry.

(i) Parallel Lines

Parallel lines are lines that lie in the same plane and never intersect, no matter how far they are extended. A more formal definition:

Two lines and are said to be parallel if they are coplanar and do not intersect when produced indefinitely on either side.

Terms that need to be defined first: **Line**, **Plane**, **Intersect**. A line can be understood as a straight, one-dimensional figure extending infinitely in both directions. A plane is a flat, two-dimensional surface extending infinitely in all directions. Intersection refers to the point where two or more lines meet.

(ii) Perpendicular Lines

Perpendicular lines are lines that intersect at a right angle (90 degrees). A more formal definition:

Two lines and are said to be perpendicular if they intersect such that the angle between them is .

Terms that need to be defined first: **Line**, **Intersect**, **Angle**, **Right Angle**. An angle is the figure formed by two rays sharing a common endpoint. A right angle is an angle measuring 90 degrees.

(iii) Line Segment

A line segment is a part of a line that is bounded by two distinct endpoints, and contains every point on the line between its endpoints. A more formal definition:

A line segment is a part of a line with two endpoints.

Terms that need to be defined first: **Line**, **Point**, **Endpoint**. A point is an exact location in space.

(iv) Radius of a Circle

The radius of a circle is the distance from the center of the circle to any point on the circle. A more formal definition:

The radius of a circle is the length of the line segment joining the center to any point on the circle.

Terms that need to be defined first: **Circle**, **Center**, **Point**, **Line Segment**. A circle is the set of all points equidistant from a central point.

(v) Square

A square is a quadrilateral with four equal sides and four right angles. A more formal definition:

A square is a quadrilateral in which all four sides are equal and all four angles are right angles.

Terms that need to be defined first: **Quadrilateral**, **Side**, **Angle**, **Right Angle**, **Equal**. A quadrilateral is a four-sided polygon.

ANSWER

There are several undefined terms which the student should list. They are consistent, because they deal with two different situations — (i) says that given two points A and B, there is a point C lying on the line in between them; (ii) says that given A and B, you can take C not lying on the line through A and B.

These 'postulates' do not follow from Euclid's postulates. However, they follow from Axiom 5.1.

Question 3

QUESTION

Consider two ‘postulates’:

(i) Given any two distinct points A and B, there exists a third point C which is in between A and B.
(ii) There exist at least three points that are not on the same line.

Do these postulates contain any undefined terms? Are these postulates consistent? Do they follow from Euclid’s postulates? Explain.

SOLUTION

This question asks us to analyze two given postulates in the context of Euclidean geometry, identifying undefined terms, checking for consistency, and determining if they follow from Euclid's postulates.

Step 1: Identify undefined terms

The undefined terms in the given postulates include:

- **Point:** The postulates refer to 'points' (A, B, C) without defining what a point is.
- **Line:** Postulate (ii) mentions points "not on the same line," implying the concept of a line is understood but not defined.
- **Between:** Postulate (i) uses the term "in between," which is an undefined spatial relationship.

Step 2: Check for consistency

The postulates are consistent because they do not contradict each other. Postulate (i) states that given two distinct points, there exists a point between them, implying collinearity. Postulate (ii) states that there exist at least three points not on the same line, implying non-collinearity. These postulates address different geometric configurations and do not lead to any logical contradiction.

Step 3: Determine if they follow from Euclid's postulates

These postulates do not directly follow from Euclid's postulates. Euclid's postulates primarily deal with constructing lines and circles and defining basic geometric properties. The given postulates introduce concepts of points lying between other points and the existence of non-collinear points, which are not explicitly covered in Euclid's initial postulates.

Step 4: Relate to Axiom 5.1

The given postulates align with Axiom 5.1, which states that given two points, there is a unique line passing through them. The postulates expand on this by introducing the concept of points lying between two given points on a line and the existence of points not on that line. Thus, while not directly derived from Euclid's postulates, they are consistent with and expand upon related axioms.

Final Answer: The postulates contain undefined terms (point, line, between). They are consistent. They do not directly follow from Euclid’s postulates but follow from Axiom 5.1.

ANSWER

There are several undefined terms which the student should list. They are consistent because they deal with two different situations — (i) says that given two points A and B, there is a point C lying on the line between them; (ii) says that given A and B, you can take C not lying on the line through A and B.

These ‘postulates’ do not follow from Euclid’s postulates. However, they follow from Axiom 5.1.

Question 4

QUESTION

If a point C lies between two points A and B such that AC = BC, then prove that AC = (1/2) AB.

SOLUTION

This question tests our understanding of Euclid's axioms, particularly the one about adding equals to equals.

Step 1: State the given information

We are given that point C lies between points A and B, and that AC = BC.

Step 2: Apply Euclid's Axiom

Euclid's axiom states that if equals are added to equals, the wholes are equal. We can add AC to both sides of the equation AC = BC:

Adding AC to both sides:

Step 3: Simplify the equation

On the left side, simplifies to . On the right side, is the sum of the lengths of the two segments AC and BC. Since C lies between A and B, the sum of these lengths is equal to the length of the entire segment AB. This is based on another of Euclid's axioms: "The whole is greater than the part," and its corollary that the parts add up to the whole.

Therefore, we can rewrite the equation as:

Step 4: Isolate AC

To find the value of AC, we divide both sides of the equation by 2:

This simplifies to:

Final Answer:

Conclusion: By using Euclid's axioms about adding equals to equals and the relationship between parts and wholes, we have successfully proven that if AC = BC, then AC is half the length of AB.

ANSWER

AC = BC

So, AC + AC = BC + AC (Equals are added to equals)

i.e., 2AC = AB (BC + AC coincides with AB)

Therefore, AC = 1/2 AB

Question 5

QUESTION

In Question 4, point C is called a mid-point of line segment AB. Prove that every line segment has one and only one mid-point.

SOLUTION

This question asks us to prove that a line segment can have only one midpoint. We will use proof by contradiction, assuming there are two midpoints and showing that this leads to a contradiction.

Step 1: Assume two midpoints exist

Let's assume, for the sake of contradiction, that line segment AB has two distinct midpoints, C and D. This means that C and D are different points on the line segment AB such that:

(Since C is a midpoint)

(Since D is a midpoint)

Step 2: Equate the two expressions

Since both and are equal to half the length of , we can equate them:

Step 3: Analyze the implication of

If , it means the distance from point A to point C is the same as the distance from point A to point D. Since C and D are on the same line segment AB, the only way for to equal is if C and D are actually the same point.

Step 4: State the contradiction

Our assumption was that C and D are *different* points. However, we have shown that implies that C and D must be the same point. This contradicts our initial assumption.

Step 5: Conclude that there is only one midpoint

Since our assumption that there are two distinct midpoints leads to a contradiction, our assumption must be false. Therefore, a line segment can have only one midpoint.

ANSWER

Make a temporary assumption that different points C and D are two mid-points of AB. Now, you show that points C and D are not two different points.

Question 6

QUESTION

In Fig. 5.10, if AC = BD, then prove that AB = CD.

SOLUTION

This question tests our understanding of Euclid's axioms, specifically the axiom that states "if equals are subtracted from equals, the remainders are equal". We need to use the given information (AC = BD) and the geometric relationships in the figure to prove that AB = CD.

Step 1: State the given information

We are given that .

Step 2: Express AC and BD in terms of AB, BC, and CD

From the figure, we can see that point B lies between A and C, and point C lies between B and D. Therefore, we can write:

and

Step 3: Substitute the expressions for AC and BD into the given equation

Since , we can substitute the expressions we found in Step 2:

Step 4: Apply Euclid's axiom

We have the equation . We can subtract from both sides of the equation. According to Euclid's axiom, "if equals are subtracted from equals, the remainders are equal". Therefore:

Step 5: Simplify the equation

Simplifying the equation, we get:

Final Answer:

Conclusion:

By expressing the line segments AC and BD in terms of smaller segments and applying Euclid's subtraction axiom, we have successfully proven that .

ANSWER

AC = BD (Given)

AC = AB + BC (Point B lies between A and C)

BD = BC + CD (Point C lies between B and D)

Substituting, AB + BC = BC + CD

So, AB = CD (Subtracting equals from equals)

Question 7

QUESTION

Why is Axiom 5, in the list of Euclid's axioms, considered a 'universal truth'?

SOLUTION

The question asks us to explain why Euclid's Axiom 5 is considered a universal truth.

Step 1: Recall Euclid's Axiom 5

Euclid's Axiom 5, also known as Playfair's Axiom, can be stated as follows: "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, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles."

Step 2: Understand the implication of the axiom

This axiom essentially describes a fundamental property of parallel lines in Euclidean geometry. It states that if two lines are not parallel, they will eventually intersect if extended far enough on the side where the interior angles sum to less than 180 degrees (two right angles). The key idea is that this behavior is not specific to any particular location or object.

Step 3: Explain why it's a universal truth

The reason Axiom 5 is considered a 'universal truth' is because it's a statement about the fundamental nature of space and straight lines as conceived in Euclidean geometry. It doesn't depend on any specific measurements, constructions, or physical objects. It holds true regardless of where you are in the universe (assuming Euclidean geometry applies). The relationship between lines and angles described by the axiom is consistent everywhere.

Step 4: Summarize

Because Axiom 5 describes a fundamental and universally applicable property of lines and angles, independent of specific instances or locations, it is considered a universal truth within the framework of Euclidean geometry. It's a foundational principle upon which many other geometric theorems are built, and its validity is assumed to be constant across all of space.

Final Answer: Since this is true for anything in any part of the world, this is a universal truth.

ANSWER

Since this is true for anything in any part of the world, this is a universal truth.

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📐 Key Formulas

Important Formulas for Exercise 5.1

Formula / Concept	Description
Euclid's Definitions	
A point	A point is that which has no part.
A line	A line is a breadthless length.
The ends of a line	The ends of a line are points.
A straight line	A straight line is a line which lies evenly with the points on itself.
A surface	A surface is that which has length and breadth only.
The edges of a surface	The edges of a surface are lines.
A plane surface	A plane surface is a surface which lies evenly with the straight lines on itself.
Euclid's Axioms (Common Notions)	
Axiom 1	Things which are equal to the same thing are equal to one another.
Axiom 2	If equals are added to equals, the wholes are equal.
Axiom 3	If equals are subtracted from equals, the remainders are equal.
Axiom 4	Things which coincide with one another are equal to one another.

Formula / Concept	Description
Axiom 5	The whole is greater than the part.
Axiom 6	Things which are double of the same things are equal to one another.
Axiom 7	Things which are halves of the same things are equal to one another.
Euclid's Postulates	
Postulate 1	A straight line may be drawn from any one point to any other point.
Postulate 2	A terminated line can be produced indefinitely.
Postulate 3	A circle can be drawn with any center and any radius.
Postulate 4	All right angles are equal to one another.
Postulate 5	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, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.

? Top FAQs

Q1. How many questions are included in NCERT Solutions for Class 9 Maths Chapter 5 Introduction to Euclid's Geometry Exercise 5.1 for CBSE board exam 2025-26?

Exercise 5.1 of NCERT Solutions Class 9 Maths Chapter 5 Introduction to Euclid's Geometry contains exactly 7 questions. These questions are based on Euclid's definitions, axioms, and postulates, which form the foundation of geometry for CBSE Class 9 students preparing for the 2025-26 board exams.

Q2. Where can I download free PDF of NCERT Solutions for Class 9 Maths Chapter 5 Introduction to Euclid's Geometry Exercise 5.1 with step by step solutions?

You can download the free PDF of NCERT Solutions for Class 9 Maths Chapter 5 Introduction to Euclid's Geometry Exercise 5.1 from the official NCERT website or various educational platforms offering step by step solutions. These PDFs are updated according to the latest CBSE syllabus 2025-26 and include detailed explanations of all 7 questions covering Euclid's axioms and postulates.

Q3. How many marks does Introduction to Euclid's Geometry Chapter 5 Exercise 5.1 carry in CBSE Class 9 Maths board exam 2025-26?

NCERT Class 9 Maths Chapter 5 Introduction to Euclid's Geometry carries approximately 5 marks as part of Unit IV - Geometry in the CBSE board exam 2025-26. Exercise 5.1 covers fundamental concepts of Euclid's definitions, axioms, and postulates that are essential for understanding the complete geometry unit.

Q4. Which is the most difficult question in Exercise 5.1 of NCERT Solutions for Class 9 Maths Chapter 5 Introduction to Euclid's Geometry with step by step solutions?

Question 5 and Question 7 in Exercise 5.1 of NCERT Class 9 Maths Chapter 5 Introduction to Euclid's Geometry are considered the most challenging by students. These questions require understanding the differences between Euclid's axioms and postulates, and applying them to prove geometric statements, which can be solved easily with proper step by step solutions and practice for CBSE board exam 2025-26.

Q5. What are Euclid's Axioms explained in NCERT Solutions for Class 9 Maths Chapter 5 Introduction to Euclid's Geometry Exercise 5.1?

Euclid's Axioms in NCERT Class 9 Maths Chapter 5 are universal truths that apply to all branches of mathematics, such as 'things which are equal to the same thing are equal to one another' and 'if equals are added to equals, the wholes are equal.' Exercise 5.1 contains 7 questions that help students understand and apply these axioms for CBSE board exam 2025-26 preparation with step by step solutions.

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