8 Playing with Constructions

Why This Chapter Matters

Have you ever wondered how architects design towering skyscrapers that are perfectly straight? Or how artists create beautiful, symmetrical patterns like mandalas? How do cartographers draw maps where every city is in the exact right spot? The secret isn't magic—it's mathematics! Specifically, it's the art of geometric construction. This is where we use simple tools to draw complex shapes with perfect accuracy. In this chapter, we'll become mathematical architects, using rulers and compasses to build a world of precise shapes.

Meet EeeBee.AI

Hi, I'm EeeBee! I love building things, from robot friends to cool gadgets. But every great creation starts with a perfect plan. That's where geometry comes in! I've got my trusty digital ruler and compass ready. Throughout this chapter, I'll be your construction partner, sharing tips, pointing out tricky spots, and helping you draw shapes so precisely that they look like they were made by a machine! Let's start building our knowledge together!

Learning Outcomes

By the end of this chapter, students will be able to:

- Construct a circle of any given radius using a compass.
- Define the properties of squares and rectangles.
- Construct squares and rectangles with given side lengths using a ruler and protractor.
- Explore and verify the properties of diagonals in squares and rectangles.
- Construct the perpendicular bisector of a line segment.
- Apply construction techniques to solve simple practical problems.

From Last Year's Notebook

- You can identify lines, angles, and polygons. You have used a ruler to measure and draw, and you can classify angles as acute, obtuse, or right.
- Now, we will build on that! You will learn to construct these shapes with perfect accuracy using a compass and ruler.
- **The Big Idea:** Think of it as upgrading your skills from freehand sketching to precise engineering!

Real Math, Real Life

Geometric constructions are the secret tools behind amazing designs and inventions. This chapter gives you the foundational skills used in many exciting fields.

Here's a glimpse:

- **Architecture:** To design blueprints for massive buildings, bridges, and parks.
- **Graphic Design:** To create cool logos and digital art with perfect shapes and balance.
- **Engineering:** To build precise parts for everything from cars to smartphones.
- **Astronomy:** To map the stars and understand the geometry of our universe.

Quick Prep

1. Which instrument from your geometry box would you use to draw a straight line of 8 cm?
2. What is the line segment from the center of a circle to its edge called?
3. If you trace the outline of a coin, what shape do you get?
4. How many degrees are in a full circle?
5. Can you draw a perfect circle freehand? Why or why not?
6. What is the difference between a line and a line segment?

Introduction

Welcome to the world of geometric construction! What's the difference between sketching a circle and constructing one? Precision! In mathematics, "**construction**" means drawing geometric figures accurately using only specific tools, like a compass and a straightedge. It's like being a detective who follows strict clues to reveal a perfect shape. In this first section, we'll get to know our essential tools and master the construction of one of the most fundamental and perfect shapes in the universe: the circle.

Chapter Overview

In this chapter, we will become geometric architects! Here is a map of what you will learn:

- **Master Your Toolkit:** We will learn the precise use of the ruler, compass, and protractor to become expert builders.
- **Constructing Shapes:** You'll master the step-by-step methods for drawing perfect circles, rectangles, and squares.
- **Uncovering Geometric Secrets:** We will explore powerful constructions like perpendicular bisectors and learn about the special properties of diagonals.
- **Bringing Geometry to Life:** We'll apply our new skills to create amazing art and see how they are used in real-world design and engineering.

From History's Pages

The art of geometric construction is ancient, pioneered by the Greek mathematician Euclid, often called the "Father of Geometry." Over 2,000 years ago, he established a key rule: true constructions must only use an unmarked straightedge and a compass. In his famous book Elements, he demonstrated how to create complex shapes with just these tools. The logical, step-by-step methods we learn today come directly from Euclid's work, showing that geometry is about the precise process of creation.

The Tools of Construction

To become a master builder in geometry, you first need to know your tools. Just like a carpenter has a hammer and saw, a geometer has a special toolkit for creating precise figures. We will focus on three primary tools. While ancient Greeks used an unmarked straightedge, we will use a **modern ruler**. We will also use the **compass**, a magical device for drawing perfect circles, and the **protractor**, for measuring and creating angles. Mastering these tools is the first step to creating any geometric design you can imagine.

Key tools

In formal geometry, construction relies on a set of agreed-upon rules or "**postulates.**" The tools are the physical embodiment of these rules.

- **The Ruler:** A ruler allows us to apply the postulate that a straight line can be drawn between any two points. When we use its markings, we are measuring a specific length, a fundamental skill for constructing figures with given dimensions. For accuracy, always use a sharp pencil and view the ruler markings from directly above to avoid parallax error.
- **The Compass:** The compass is key to defining a circle. A circle is the set of all points equidistant from a central point. The compass mechanically achieves this. By fixing the pointer (the center) and rotating the pencil, you are drawing all possible points that are at a fixed distance (the radius) from the center. This tool is surprisingly powerful and can be used to bisect lines, copy angles, and construct many polygons without ever using a protractor.
- **The Protractor:** While not part of "**pure**" Euclidean construction, the protractor is an essential modern tool for practical geometry. It allows us to construct angles of specific measures, which is crucial for building shapes like rectangles and triangles with defined angles. To use it, you place the center point of the protractor on the vertex of the angle and align the 0° line with one arm of the angle. The other arm will then point to the angle's measure in degrees.

Circle

A circle is a two-dimensional geometric shape made up of all the points on a plane that are equidistant from a fixed point, known as the **center**. The constant distance from the center to any point on the circle is called the **radius**.

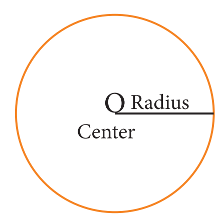


Fig. 8.1

Clock *Plate* *Coin* *Fig. 8.2*

Sub-concepts to be covered

1. **Definition of a Circle:** A circle is a two-dimensional shape formed by all the points in a plane that are at a constant distance (the radius) from a fixed point (the center).
2. **Key Parts:**
   i. **Center:** The fixed point in the middle.
   ii. **Radius:** The distance from the center to any point on the circle.
   iii. **Circumference:** The distance around the circle (the perimeter).
   iv. **Diameter:** A line segment that passes through the center and has its endpoints on the circle. It is always twice the length of the radius.

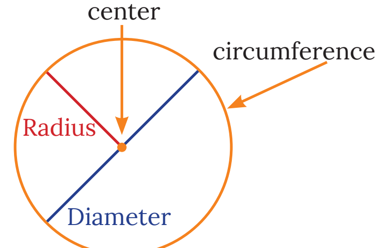


Fig. 8.3

3. **Steps to Construct a Circle of a Given Radius:** This involves setting the compass to the correct width using a ruler and then drawing the circle.

Mathematical Explanation

Constructing a Circle

The circle is a shape of perfect symmetry. Every point on its edge is exactly the same distance from the center. This simple property makes it one of the most important shapes in nature and design, from planetary orbits to the wheels on your bicycle. Using a compass, we can harness this property to draw a perfect circle of any size we want. We will learn the simple, step-by-step method to construct a circle when you are given its radius.

Constructing a Circle of Any Radius Using Ruler and Compass

1. **Mark the Center Point:** Identify and mark a point O on your paper. This will serve as the center of your circle.
2. **Set the Compass Radius:** Adjust the compass by measuring the given radius on your ruler.
   Ensure the distance between the metal tip and the pencil tip matches the desired radius.
3. **Position the Compass:** Place the metal tip of the compass firmly on point O.
4. **Draw the Circle:** Rotate the compass pencil tip completely around point O, keeping the metal tip steady. Ensure a smooth and continuous motion to create a perfect circle.
5. **Complete the Circle:** Once the pencil completes a full round, you will have your circle of the specified radius.

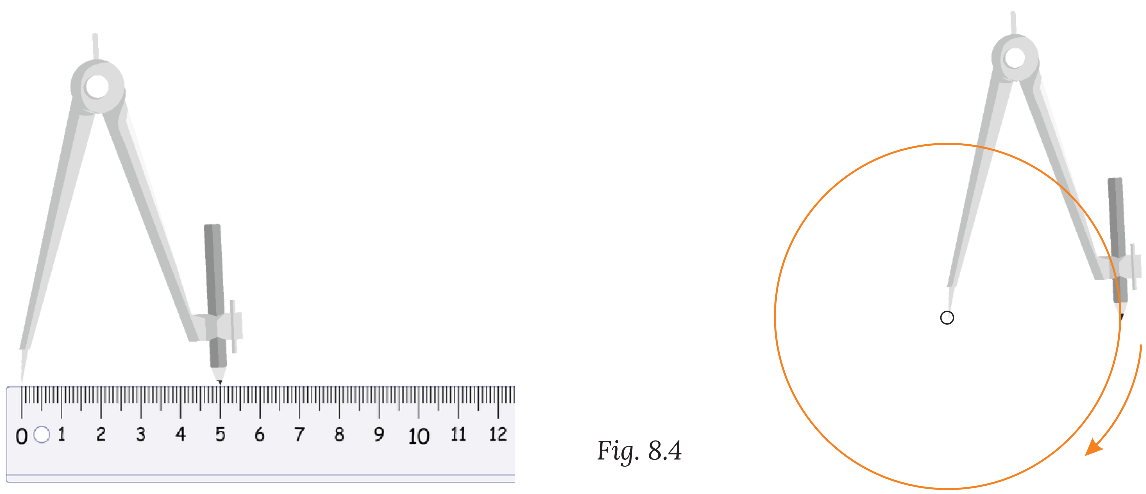


Fig. 8.4

Example 1 : Use a ruler to draw a line segment of length 7.5 cm.

Solution: **Step 1:** Place the ruler on a sheet of paper. Mark a point 'A' at the '0' mark of the ruler.
Step 2: Mark another point 'B' at the 7.5 cm mark (the line halfway between 7 and 8).
Step 3: Use a sharp pencil to draw a straight line connecting point A and point B. This is the line segment AB of length 7.5 cm.

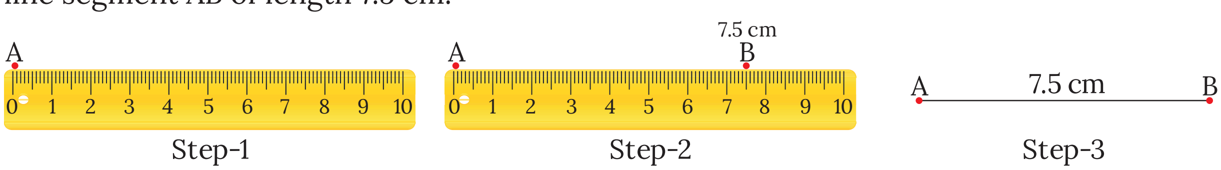


Fig. 8.5

Example 2 : How would you set your compass to draw a circle with a radius of 5 cm?

Solution: **Step 1:** Place your ruler on the desk.

Step 2: Take your compass. Place the metal pointer of the compass on the '0' mark of the ruler.

Step 3: Carefully open the compass arms until the pencil tip is exactly on the '5 cm' mark of the ruler.

Step 4: The compass is now set to a radius of 5 cm. Be careful not to change the width as you lift it.

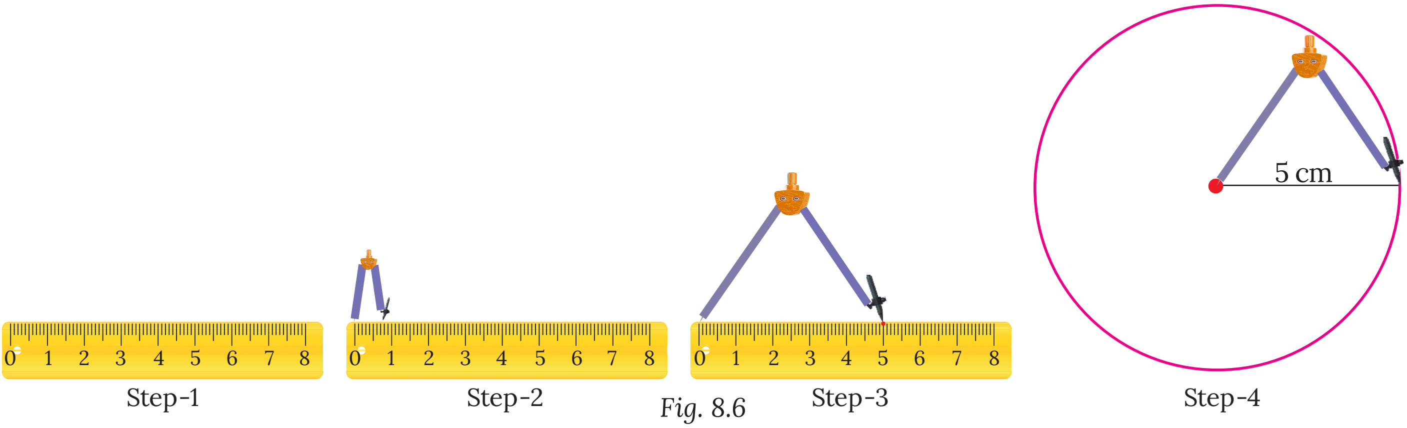


Fig. 8.6

Example 3 : Let A and B be the centers of two circles, each with a radius of 4 cm. Draw the two circles such that the center of one circle lies on the circumference of the other. Let the two circles intersect at points X and Y. Verify whether the line segments AB and XY are perpendicular to each other.

Solution: **Steps for Construction**

Draw the First Circle: Draw a point A on your paper. Using a compass, draw a circle with center A and radius 4 cm.

1. **Mark a Point on the Circumference:** Select a point B on the circumference of the first circle.
2. **Draw the Second Circle:** With B as the center and a radius of 4 cm, draw another circle such that it passes through point A.
3. **Label the Points of Intersection:** Mark the intersection points of the two circles as X and Y.
4. **Join the Line Segments:** Draw the line segments AB and XY.
5. **Measure the Angles:** Use a protractor to measure ∠XAY and ∠XBY.

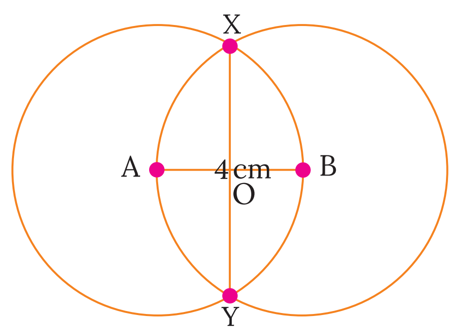


Fig. 8.7

Upon measurement: ∠XOA = 90° and ∠XOB = 90°.

This confirms that the line segments AB and XY are perpendicular to each other, as they intersect at a right angle.

Conclusion: Since the circles are of equal radius and the center of one lies on the circumference of the other, their intersection points form a line XY that is perpendicular to the line joining their centers (AB).

Knowledge Checkpoint

1. What is the main function of a compass in geometry?
2. If you want to draw a line segment of a specific length, which tool is essential?
3. What unit of measurement is found on a protractor?
4. If you are asked to construct a circle of radius 4 cm, what is the first step?
5. What is the relationship between the radius and diameter of a circle?

Activity

Compass Art

Objective: To get comfortable using a compass to create patterns.

Materials: Compass, ruler, pencil, plain paper.

Procedure:

- ♦ Set your compass to a radius of 4 cm. Draw a circle in the center of your paper.
- ♦ Without changing the radius, place the compass pointer anywhere on the circle's edge and draw an arc that cuts through the circle.
- ♦ Move the pointer to one of the intersection points and draw another arc.
- ♦ Continue this process around the circle. You should end up with a beautiful six-petaled flower design inside your circle!

- **Inquiry Question:** Why do you think placing the pointer on the edge and using the same radius creates this perfect pattern? (**Hint:** It relates to equilateral triangles!)

Key Terms

- **Arc:** A part of the circumference of a circle.
- **Center:** The fixed point from which all points on the circle are equidistant.
- **Radius (r):** The distance from the center to any point on the circle.
- **Diameter (d):** A line segment passing through the center with endpoints on the circle. ($d = 2r$)
- **Concentric Circles:** Circles that have the same center but different radii.

Do It Yourself

Could you construct a square using only a compass and an unmarked straightedge? You can't measure 90° with a protractor. How might you create a perfect right angle using just arcs and lines? (This is a classic challenge that we will explore later!)

Facts Flash

a) A compass can be used to find the North direction if you have a watch! It's a bit of a survival trick.

b) The circle is considered the most "efficient" shape because it encloses the most area for a given perimeter. That's why soap bubbles are spherical (a 3D circle)!

Mental Mathematics

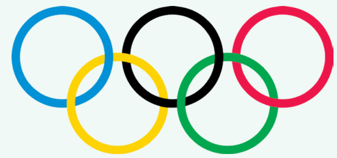
- If the radius of a circle is 7 cm, what is its diameter?
- If you draw a line segment of 10 cm and want to mark its midpoint, what measurement would that be?
- A pizza has a radius of 15 cm. What is its diameter?
- You draw a circle. You then draw another circle with double the radius. Will its diameter also be double?

Exercise 8.1

Gap Analyzer™ Homework

Watch Remedial

1. Draw a circle with a radius of 4 cm.
2. With the same center O, draw three additional circles of radii 6 cm, 4.5 cm, and 2.8 cm.
3. Let C and D be the centers of two circles with equal radii of 5 cm. Draw them so that each circle passes through the center of the other. Let the circles intersect at points X and Y. Examine whether CD and XY are perpendicular.
4. The Olympic logo is made of 5 interlocked circles. Choosing radius of each circle as 4cm, can you try drawing it with a compass?



5. Draw two circles of radius 6 cm centered at points E and F such that each circle passes through the center of the other. Find the points of intersection of the circles, and examine if EF and the line through the points of intersection are perpendicular.

6. Design your own donut. Take radius of the outer part 8 cm and inner part 3 cm. Find the outer and inner diameters.
7. Draw a bicycle wheel by making two circles — one with diameter 12 cm (outer circle) and another with diameter 10 cm (inner circle). Now, draw straight lines across the inner circle to show the spokes of the wheel.

8. **Designing a Rangoli:** Anjali is making a circular Rangoli pattern for a festival. She starts by drawing a circle with a radius of 7 cm. She wants to place 6 identical, equally spaced diyas (lamps) on the circumference of this circle. Show the construction steps to accurately find the positions for all 6 diyas.

Square

Now that we've mastered the perfect curves of circles, let's turn our attention to the straight lines and sharp corners of quadrilaterals. In this section, we will focus on two of the most familiar shapes: the square and the rectangle. You see them everywhere, from the screen you're reading on to the doors and windows of your home. We'll go beyond just recognizing them.

Top of Table Blackboard Door

Fig. 8.8

The square is a special, more perfect version of a rectangle. What makes it special? Not only does it have four right angles, but all four of its sides are equal in length.

Sub-concepts to be covered

1. **Properties of a Square:**
2. **Steps to Construct a Square:**

Mathematical Explanation

A square is a special type of rectangle where all four sides are equal in length. In a square, all angles are right angles (90°), and opposite sides are parallel.

Properties of a Square

1. All four sides are of equal length.
2. All four angles are 90 degrees.
3. Opposite sides are parallel.
4. Diagonals are equal in length and bisect each other at right angles.

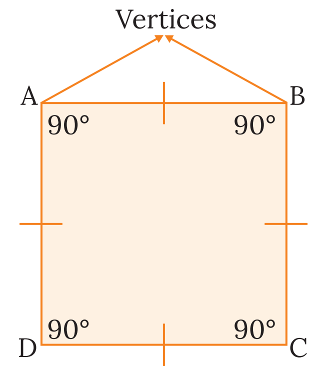


Fig. 8.9

In the given square ABCD, the lines AB, BC, CD, and DA are called the sides of the square, and the points A, B, C, and D are the corners of the square. The side AB is opposite to side CD, and side AD is opposite to side BC. All four sides of a square are equal in length. Therefore, AB = BC = CD = DA.

The four angles ∠A, ∠B, ∠C, and ∠D are each 90°, meaning the angles of a square are right angles. When naming a square, we list the vertices in the order in which they appear, starting from any corner. For example, the above square can be named as ABCD, BCDA, CDAB, DABC, etc. However, we cannot name it as ACDB or ABDC.

Constructing a Square

A square is a special type of rectangle where all four sides are of equal length, and all four angles are 90°. Here's how you can construct a square using basic geometric tools like a ruler and a protractor.

Steps to Construct a Square:

1. **Draw the First Side (AB):** Using a ruler, draw a straight line segment of the desired length. This will be one side of the square, say AB.

Fig. 8.10

2. **Draw the Adjacent Side (AD):** Place the protractor at point A. Measure a 90° angle and mark point D such that the length of AD is the same as AB (this is the side length of the square).

   Use the ruler to connect points A and D.

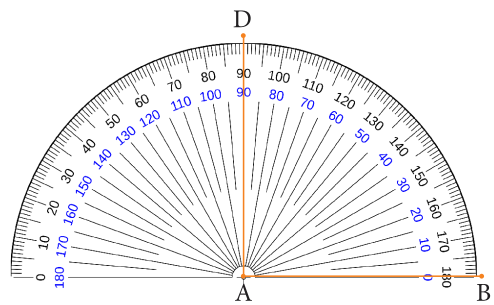


Fig. 8.11

3. **Draw the Opposite Side (BC):** Now, using a ruler, draw a line segment BC equal in length to AB. Make sure this line is parallel to side AD (you can use a set square or ruler to ensure the parallelism). **(Fig. 8.12)**

   Mark point C.

4. **Draw the Final Side (CD):** Connect point C to point D. This side should be equal in length to AD and AB.**(Fig. 8.13)**

The side CD will complete the square.

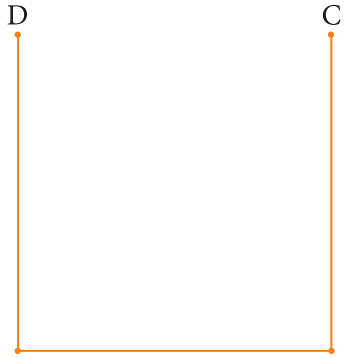


Fig. 8.12

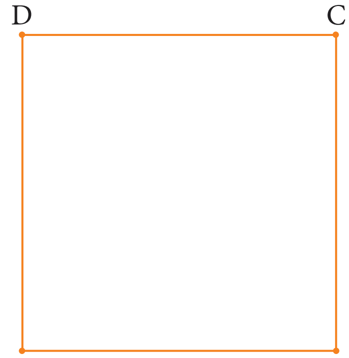


Fig. 8.13

5. **Check the Angles:** Use a protractor to check if all four angles are 90° to ensure it's a perfect square.

Example: Let's say you want to construct a square with a side length of 5 cm.

Step 1. Draw AB = 5 cm. **(Fig. 8.14)**

Step 2. At point A, measure a 90° angle, and mark AD = 5 cm. **(Fig. 8.15)**

Fig. 8.14

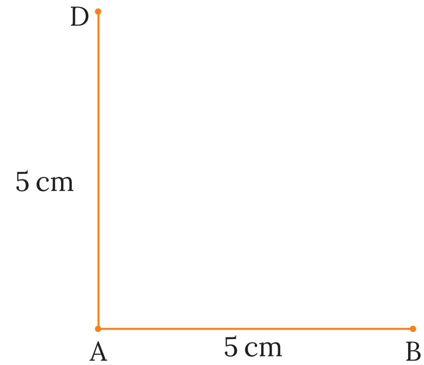


Fig. 8.15

Step 3. Draw BC = 5 cm parallel to AD. **(Fig. 8.16)**

Step 4. Finally, connect C to D to complete the square. **(Fig. 8.17)**

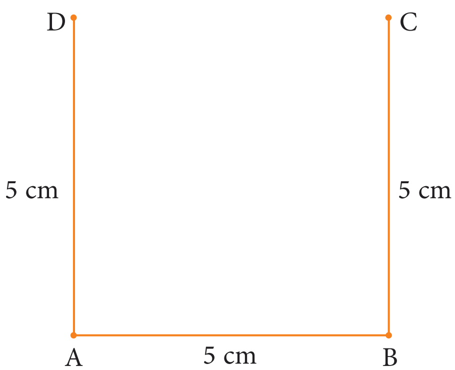


Fig. 8.16

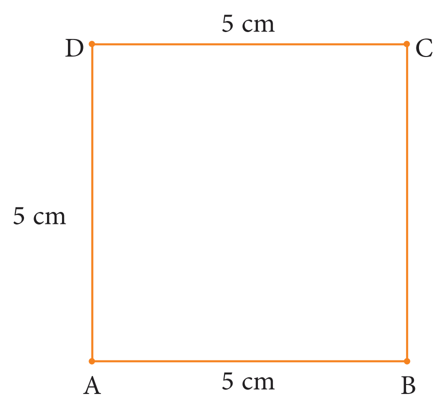


Fig. 8.17

Knowledge Checkpoint

1. What is the minimum information needed to construct a square?
2. **True or False:** All squares are rectangles.
3. If you have constructed three sides of a square, is the fourth side's length and position already determined?

Key Terms

- **Square:** A quadrilateral with four equal sides and four right angles.
- **Side:** One of the line segments that form a polygon. In a square, all four sides are equal.

Do It Yourself

You can construct a square given its side. Can you construct a square if you are only given the length of its diagonal? How would you start?

(**Hint:** Think about the properties you discovered in the paper folding activity!)

Facts Flash

a) A square is the quadrilateral with the largest area for a given perimeter.

b) In a "magic square," numbers are arranged in a square grid so that the sum of the numbers in each row, column, and main diagonal is the same.

Mental Mathematics

- Side of a square = 7 cm. Perimeter = ?
- Perimeter of a square = 40 m. Side = ?
- Area of a square with side 5 cm = ?
- Are the diagonals of a square equal?
- A square is cut in half along its diagonal. What two shapes are formed?

Rectangle

A rectangle is a quadrilateral where opposite sides are equal in length, and all four angles are 90°. A rectangle is a more general shape compared to a square, where only the opposite sides need to be equal, not all four sides.

Sub-concepts to be covered

1. **Properties of a Rectangle:**
2. **Steps to Construct a Rectangle:**

Mathematical Explanation

Properties of a Rectangle

1. Opposite sides are equal in length.
2. All four angles are 90 degrees.
3. Opposite sides are parallel.
4. Diagonals are equal in length but not necessarily bisect each other at right angles.

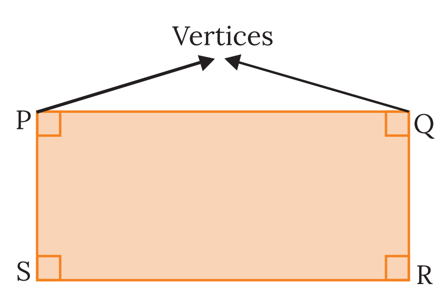


Fig. 8.18

In the given rectangle PQRS, the lines PQ, QR, RS, and SP are called the sides of the rectangle, and the points P, Q, R, and S are the corners of the rectangle. The side PQ is opposite to side RS, and side PS is opposite to side QR. Opposite sides of a rectangle are equal in length. Therefore, PQ = RS and PS = QR.

The four angles ∠P, ∠Q, ∠R, and ∠S are each 90°, meaning the angles of a rectangle are right angles. When naming a rectangle, we list the vertices in the order in which they appear, starting from any corner. For example, the above rectangle can be named as PQRS, QRSP, RSPQ, SPQR, etc. However, we cannot name it as PRQS or QSPR.

Constructing a Rectangle

Constructing a rectangle involves creating a quadrilateral with specific properties: opposite sides are equal in length, and all four angles are 90° (right angles). Here's how you can construct a rectangle using basic geometric tools like a ruler and a protractor.

Steps to Construct a Rectangle

1. **Draw the First Side (AB):** Using a ruler, draw a straight line segment of the desired length. This will be one of the sides of the rectangle, say AB.

Fig. 8.19

2. **Draw the Adjacent Side (AD)**
   - Place the protractor at point A. Measure a 90° angle and mark a point D such that AD is the desired length.
   - Use the ruler to connect points A and D.

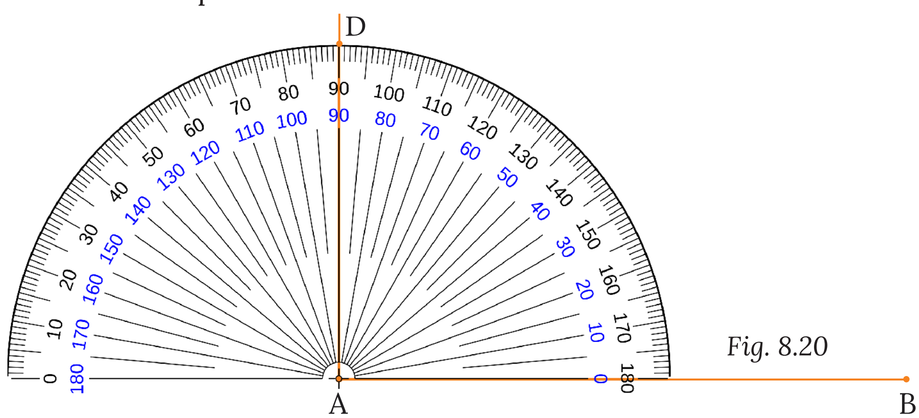


Fig. 8.20

3. **Draw the Opposite Side (BC)**
   - Now, using a ruler, draw a line segment BC equal in length to side AB. Make sure this line is parallel to side AD (you can use a set square or ruler to ensure the parallelism). **(Fig. 8.21)**
   - This will be the second pair of opposite sides of the rectangle.
4. **Draw the Final Side (CD):** Finally, connect point C to point D. This side should be equal in length to side AD and parallel to side AB. **(Fig. 8.22)**

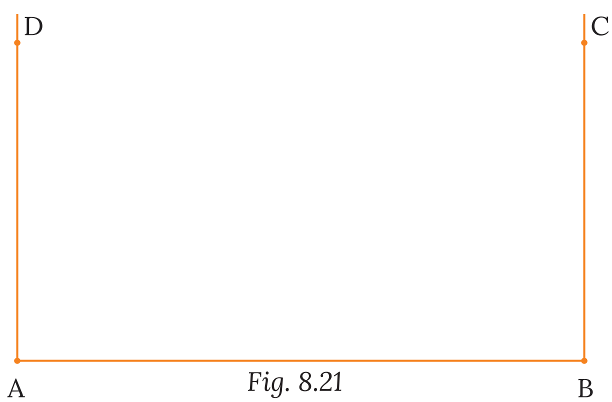


Fig. 8.21

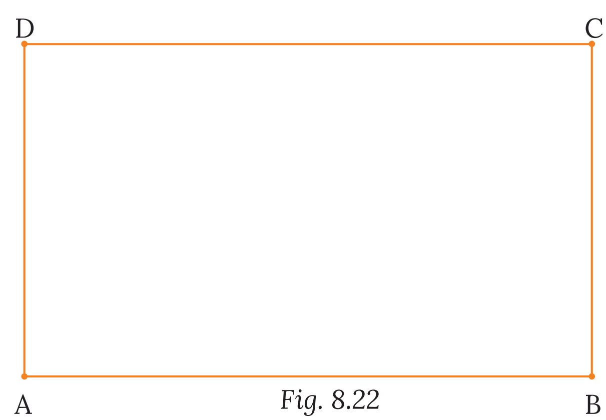


Fig. 8.22

5. **Check the Angles:** Use a protractor to check if all four angles of the rectangle are 90°.

Example: Let's say you want to construct a rectangle with a length of 6 cm and a width of 4 cm.

Step 1. Draw AB = 6 cm.

Fig. 8.23

Step 2. At point A, measure a 90° angle, and mark AD = 4 cm.

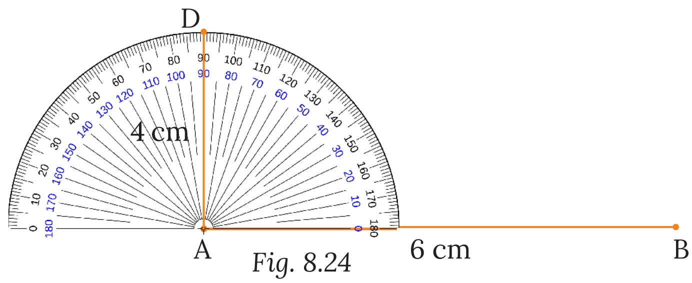


Fig. 8.24

Step 3. Draw BC = 4 cm parallel to AD.

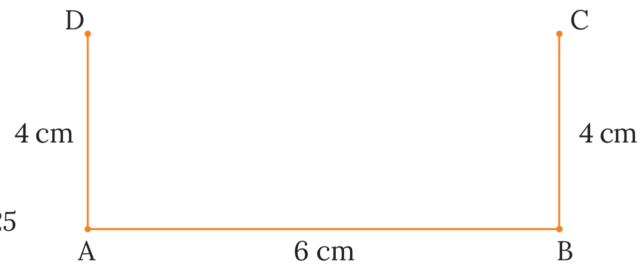


Fig. 8.25

Step 4. Finally, connect C to D to complete the rectangle.

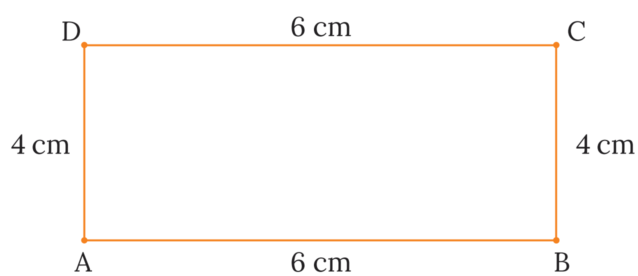


Fig. 8.26

Knowledge Checkpoint

1. What two measurements do you need to construct a unique rectangle?
2. **True or False:** All rectangles are squares.
3. How do you create the corners of a rectangle during construction?

Key Terms

- **Rectangle:** A quadrilateral with four right angles and opposite sides equal and parallel.
- **Length:** The measure of the longer side of a rectangle.
- **Width (or Breadth):** The measure of the shorter side of a rectangle.
- **Right Angle:** An angle that measures exactly 90°.

Activity

Paper Folding Rectangle

Objective: To learn the construction of rectangles and understand how they are used in real-life objects like photo frames.

Materials: White/colored sheet of paper (preferably stiff paper/card sheet)

- Ruler and pencil
- Compass (optional, for accuracy)
- Colors/sketch pens for decoration
- Scissors (optional, if cutting is allowed)

Steps:

- ♦ First, draw and cut a **large rectangle** (e.g., 14 cm × 10 cm) to act as the **background base** of the frame.
- ♦ On top of this base, draw another **large rectangle** (outer frame) of slightly smaller size (e.g., 12 cm × 8 cm).
- ♦ Inside the outer frame, construct a **smaller rectangle** (e.g., 10 cm × 6 cm) with the same center. This inner rectangle will represent the cut-out for the photo.
- ♦ Shade or colour the border region between the outer and inner rectangle.
- ♦ Place this frame rectangle on the background base so that the cut-out shows the background (this mimics a real photo placed behind the frame).
- ♦ Decorate the border with simple designs (dots, flowers, zig-zags, etc.).

- **Inquiry:** What do you notice about the opposite sides of both rectangles? (They are equal and parallel.). What shape is formed in the border region between the two rectangles? (A rectangular strip.). Can you think of other real objects where one rectangle fits inside another? (Windows, doors, TV screens, etc.)

Do It Yourself

If you have a loop of string that is 20 cm long, you can form it into many different rectangles. For example, 6 cm by 4 cm (Perimeter = 2 × (6 + 4) = 20) or 7 cm by 3 cm (Perimeter = 2 × (7 + 3) = 20). Which of all possible rectangles with a 20 cm perimeter do you think has the largest area?

Facts Flash

a) A "golden rectangle" is a special rectangle where the ratio of the length to the width is the golden ratio (approximately 1.618). It is considered to be aesthetically pleasing and is found in art, architecture, and nature.

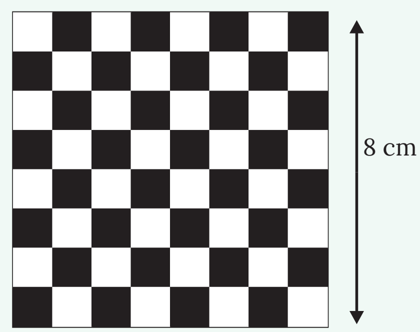
b) Any rectangle can be cut into two identical right-angled triangles by its diagonal.

Mental Mathematics

- A rectangle is 5 cm by 3 cm. What is its perimeter?
- A rectangle has a length of 10 m. The side opposite it is how long?
- If you stand in one corner of a rectangular room, what is the angle of that corner?
- Perimeter of a rectangle is 24 cm. If its length is 8 cm, what is its width?

Exercise 8.2

1. **Construct a square with the following dimensions:**
   a) Each side measuring 7 cm
   b) Each side measuring 10 cm
2. **Construct a rectangle with the following dimensions:**
   a) 6 cm by 9 cm b) 4 cm by 11 cm
   After constructing, check if the shapes satisfy the rectangle properties of having opposite sides equal and four right angles.
3. **Does the following statement stand True (T) or False (F):**
   a) A square has four sides of equal length.
   b) In a rectangle, all four angles are acute angles.
   c) Opposite sides of a square are parallel and equal in length.
   d) A rectangle can have two pairs of sides with unequal lengths.
   e) All squares are rectangles, but not all rectangles are squares.
4. A family is planning to build a rectangular swimming pool in their backyard. The length of the pool is decided to be 7 meters. The width is 4 meters. Construct a top-down view of the pool's shape using a scale of 1 cm = 1 m.
5. **Sketch your own chess board, by taking the side of the bigger square as 8 cm. Divide each side into 8 equal parts and join them with the opposite side, using by straight lines.**



   a) How many rows and columns does the chessboard have?
   b) How many total squares are formed?
   c) If each small square had a side of 1 cm, what is its area?
   d) What is the total area of the chessboard?
6. An architect is drawing a blueprint for a small rectangular study room. The room's length is 4.5 meters and its width is 3 meters. Inside the room, she wants to place a square rug with sides of 2 meters, right in the center. Using a scale of 1 cm = 0.5 m, construct the rectangular room and then construct the square rug inside it and color them.
7. Raghav wants to design a simple model of a car. To make the base structure, he first draws a big square of side 8 cm to represent the main body of the car. Then, he adds two smaller squares, each of side 3 cm, attached to the left and right sides of the big square to represent the front and backside of the car. For the wheels, he draws two circles, each of diameter 6 cm, just below the big square. Using a ruler and compass, sketch the car designed by Raghav.

Exploring Diagonals of Rectangles and Squares

We've learned to build the "walls" of our rectangles and squares. Now, let's explore what happens when we build supports inside them. A diagonal is a straight line that connects two opposite corners of a polygon. These lines are more than just simple connectors; they reveal hidden properties and symmetries of the shapes. In this section, we will construct and measure the diagonals of rectangles and squares to uncover the special rules they follow.

Diagonals of a Rectangle

A rectangle has two diagonals, and they have a very interesting relationship. While they are not part of the perimeter, they are crucial to the rectangle's structure. By constructing a rectangle and then drawing its diagonals, we can investigate two main properties: their lengths and how they intersect. You might be surprised by what you find! We will learn the properties of a rectangle's diagonals and how to construct them.

Properties of a Rectangle's Diagonals

1. **Equal Length:** The diagonals of a rectangle are always equal in length. AC = BD
2. **Bisect Each Other:** The diagonals of a rectangle bisect each other, meaning they cut each other into two equal parts at their point of intersection. AO = CO, BO = DO
3. **Not Perpendicular:** Unlike a square, the diagonals of a rectangle are not perpendicular (they do not meet at right angles).

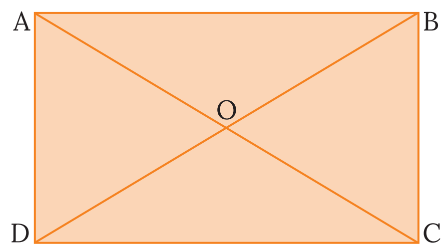


Fig. 8.27

Steps to Construct the Diagonals of a Rectangle

1. **Draw the Rectangle:** Start by drawing a rectangle using a ruler. For example, let the rectangle have a length of 6 cm and a width of 4 cm. **(Fig. 8.28)**
2. **Label the Corners:** Label the four corners of the rectangle as A, B, C, and D in clockwise or counterclockwise order. **(Fig. 8.29)**

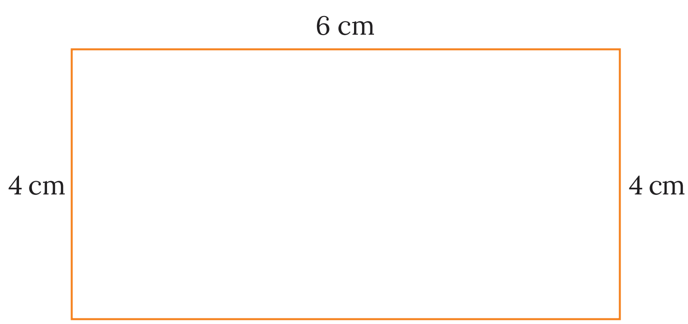


Fig. 8.28

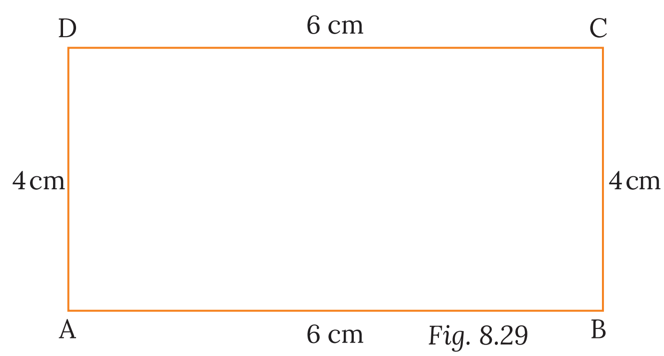


Fig. 8.29

3. **Draw the First Diagonal (AC):** Using a ruler, draw a straight line segment connecting the opposite corners A and C. This is the first diagonal of the rectangle.

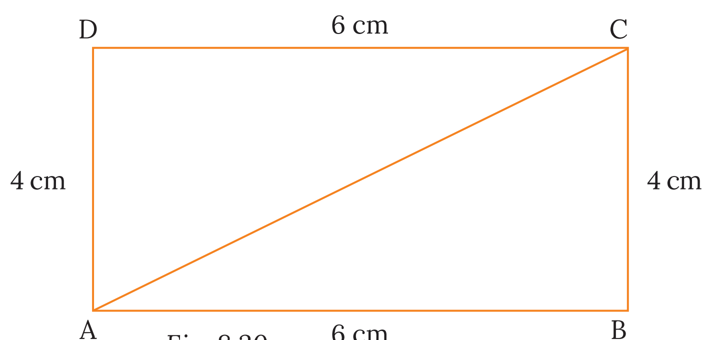


Fig. 8.30

4. **Draw the Second Diagonal (BD):** Now, using a ruler, draw the second diagonal by connecting the opposite corners B and D.

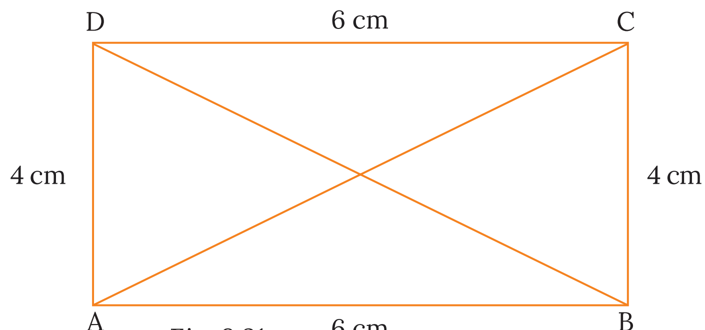


Fig. 8.31

5. **Check the Lengths:** Measure both diagonals with a ruler to confirm they are of equal length.
6. **Check the Bisecting Point:** The point where the diagonals intersect is the midpoint of both diagonals. Measure and confirm that the diagonals bisect each other (the segments of each diagonal are equal).

Example 4 : Construct a rectangle with a length of 8 cm and a width of 6 cm. Draw its diagonals and verify their properties.

Solution: **Step 1:** Construct the rectangle ABCD with AB = 8 cm and BC = 6 cm.

Step 2: Draw the diagonals AC and BD using a ruler.

Step 3: Verification:

Measure AC with a ruler. It should be 10 cm.

Measure BD with a ruler. It should also be 10 cm. (Thus, AC = BD).

Let them intersect at O. Measure AO and OC. Both should be 5 cm. Measure BO and OD. Both should be 5 cm. (Thus, they bisect each other).

Use a protractor to measure the angle ∠AOB. It will not be 90°.

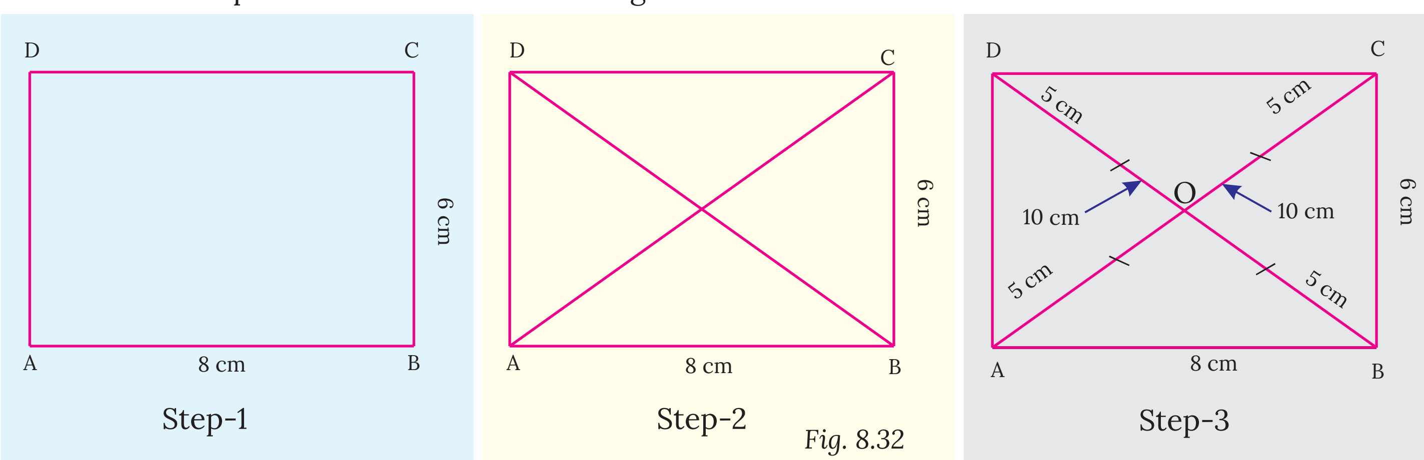


Fig. 8.32

Example 5 : Construct a rectangle where one side is 7 cm and a diagonal is 25 cm.

Solution: **Step 1:** This is tricky! Start by drawing the side AB = 7 cm.

Step 2: At B, draw a perpendicular line.

Step 3: Set your compass to 25 cm (the diagonal's length). Place the pointer at A and draw an arc to cut the perpendicular line. This point is C.

Step 4: Now you have a right-angled triangle ABC. You can complete the rectangle from here by drawing another perpendicular at A and measuring the length of BC to find point D.

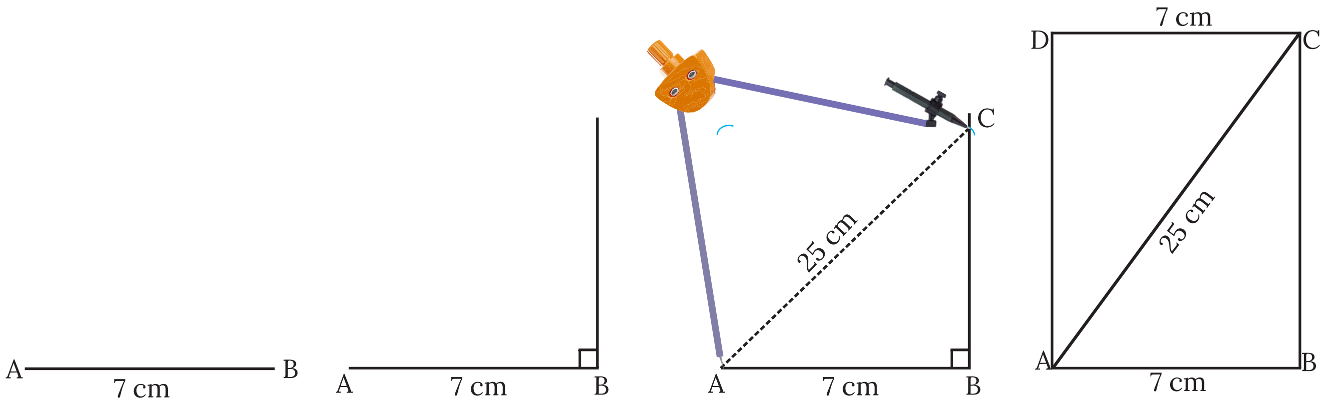


Fig. 8.33

Diagonals of a Square

Since a square is a special kind of rectangle, its diagonals share all the properties of a rectangle's diagonals: they are equal in length and they bisect each other. But the square's perfect symmetry gives its diagonals an extra, very important property. By constructing a square and its diagonals, we will discover this third property that makes the square's internal structure even more remarkable than a rectangle's.

Properties of a Square's Diagonals

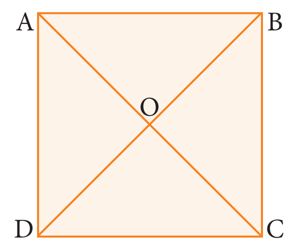


Fig. 8.34

- They are equal in length. (Inherited from rectangles) AC = BD
- They bisect each other. (Inherited from rectangles) AO = CO and BO = DO
- They are perpendicular to each other. This is the special property. The diagonals of a square always intersect at a perfect 90° angle. $\angle AOB = \angle BOC = \angle COD = \angle AOD = 90°$
- They also bisect the corner angles (each 90° corner is split into two 45° angles). $\angle OAB = \angle OAD$, similarly, angles on other corners as well.

Steps to Construct the Diagonals of a Square:

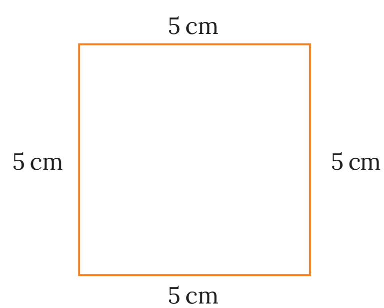


Fig. 8.35

1. **Draw the Square:** Start by drawing a square using a ruler. For example, let each side of the square be 5 cm. **(Fig. 8.35)**
2. **Label the Corners:** Label the four corners of the square as A, B, C, and D in counter clockwise order.
3. **Draw the First Diagonal (AC):** Using a ruler, draw a straight line segment connecting opposite corners A and C. This is the first diagonal of the square. **(Fig. 8.36)**
4. **Draw the Second Diagonal (BD):** Now, using a ruler, draw the second diagonal by connecting the opposite corners B and D. **(Fig. 8.37)**

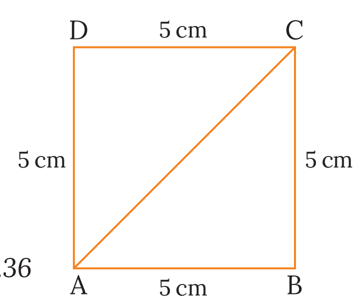


Fig. 8.36

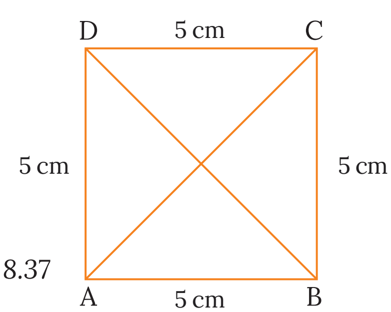


Fig. 8.37

5. **Check the Lengths:** Measure both diagonals with a ruler. Since it's a square, both diagonals should be of equal length.

6. **Check the Perpendicular Intersection:** Use a protractor to measure the angle where the diagonals intersect. The diagonals of a square meet at 90°, confirming that they are perpendicular.
7. **Check the Bisecting Point:** The diagonals of the square bisect each other, so measure and confirm that the point where they intersect divides each diagonal into two equal segments.

Example 6 : Construct a square whose diagonal is 10 cm long.

Solution: Draw a line segment **AC = 10 cm**. This will be the diagonal of the square.
Find the **midpoint O** of AC by measuring and marking the middle.
At O, construct a line **perpendicular** bisector of AC.
With O as the centre and radius equal to **OA** (half of AC = 5 cm), draw a circle.
Let the perpendicular bisector intersect the circle at points **B** and **D**.
Now join the points in order: **A–B–C–D–A**.

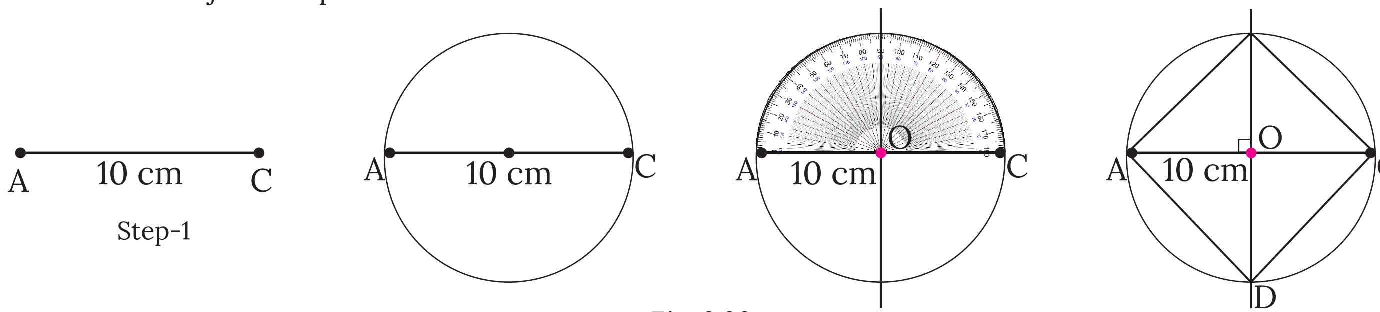


Fig. 8.38

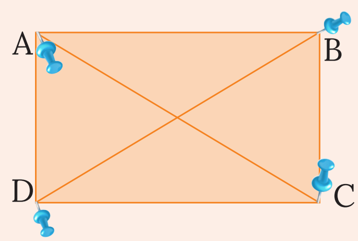
Knowledge Checkpoint

1. If one diagonal of a rectangle is 15 cm long, how long is the other diagonal?
2. If you cut a square along both its diagonals, what kind of triangles do you get? How many?
3. The diagonals of a square divide it into four smaller triangles. Are these triangles identical?

Activity

String Diagonals

Objective: To physically feel the properties of a rectangle's diagonals.



Materials: Cardboard, pins, string, ruler, protractor.

Procedure:

- Cut out a rectangle from the cardboard.
- Place pins at the four corners (A, B, C, D).
- Take a piece of string and stretch it from A to C. Cut it to that exact length.
- Take another piece of string and stretch it from B to D. Cut it.
- Compare the lengths of the two strings. Are they equal?
- Lay the strings back on the rectangle in the diagonal positions. Mark their intersection point. Do they cross at their midpoints?

Facts Flash

a) In any rectangle, the sum of the squares of the diagonals is equal to the sum of the squares of the four sides.
b) A square is the only regular polygon whose diagonals are all equal in length.

Key Terms

- **Diagonal:** A line segment connecting two non-adjacent vertices of a polygon.
- **Bisect:** To divide something into two exactly equal parts.
- **Intersection:** The point where two or more lines cross each other.
- **Perpendicular:** Lines that intersect at a right angle (90°).
- **Congruent:** Figures that are identical in shape and size.

Do It Yourself

Imagine a rectangle that is very long and thin. Now imagine a rectangle that is almost a square. In which rectangle do you think the diagonals make a smaller angle where they intersect? Can you construct examples to check your hypothesis?

Mental Mathematics

- The diagonals of a rectangle intersect at point O. If the total length of a diagonal is 12 cm, what is the length of the segment from a corner to point O?
- A square's diagonal is 14 cm. The other diagonal is?
- The diagonals of a square divide each corner angle into two smaller angles. What is the measure of these smaller angles?
- **True or False:** A square has more lines of symmetry than a non-square rectangle.

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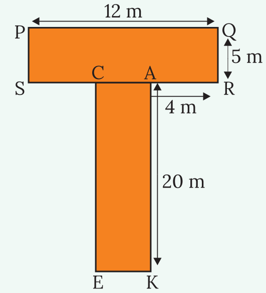
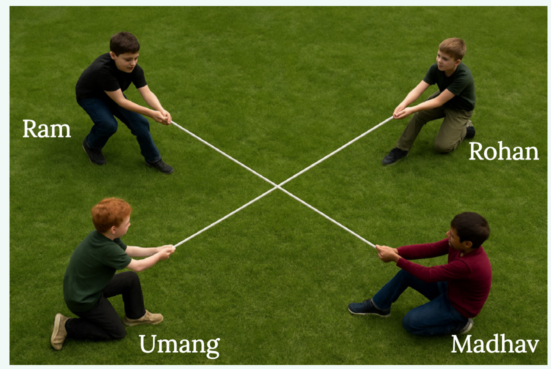
Exercise 8.3

1. **Does the following statement stand True (T) or False (F):**
   a) The diagonals of a rectangle are always equal in length.
   b) The diagonals of a rectangle bisect each other at right angles (90°).
   c) In a square, the diagonals do not bisect each other.
   d) The diagonals of a rectangle and a square are always of different lengths.
   e) The diagonals of a square form four right-angled triangles at their intersection.
2. **Construct a square in which:**
   a) The length of the diagonal is 19 cm. b) The length of the diagonal is 12 cm.
3. **Construct a rectangle in which:**
   a) One side measures 6 cm and the diagonal is of length 10 cm.
   b) One side measures 3 cm and the diagonal is of length 5 cm.
4. **Construct a square where:**
   a) One side measures 7 cm and calculate the diagonal length.
   b) One side measures 4 cm and calculate the diagonal length.

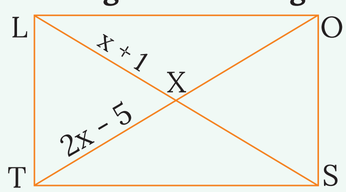
5. **Construct a rectangle in which:**
    a) One side measures 7 cm and the diagonal divides the opposite angles into 50° and 40°.
    b) One side measures 5 cm and the diagonal divides the opposite angles into 60° and 30°.
6. **Examine the given figure and answer the following questions:**



    a) What will be the value of KE?
    b) Determine the value of the diagonal QS.
    c) What is the value of ∠CAK?
    d) If we extend line segments KA and EC to join at line segment PQ at T and X respectively. Will CATX be a square or rectangle?
7. **Four friends Ram, Rohan, Madhav and Umang are playing with a string. Both the strings are of equal length. They are standing such that the distance between Rohan and Madhav is same as the distance between Umang and Madhav. Determine if the quadrilateral formed by the 4 friends will be a square or rectangle?**



    If Ram and Umang moves 1 m towards each other and similarly, Rohan and Madhav also moves 1 m towards each other, then determine if the quadrilateral formed by the 4 friends will be a square or rectangle?
8. **Find the length of diagonals of the given rectangle.**



More on Construction

We have now mastered the basics of constructing lines, circles, and key quadrilaterals. In this final section, we will learn a powerful and fundamental construction technique: creating a perpendicular bisector. This single construction allows us to do many useful things, like splitting a line segment into two perfect halves and creating a 90° angle without a protractor. It's a cornerstone of Euclidean geometry and a key to unlocking more complex constructions.

Constructing a Perpendicular Bisector

A perpendicular bisector is a line that does two things simultaneously: it is perpendicular to a given line segment, and it passes through the midpoint of that segment, thus bisecting it. The most amazing property of this line is that any point on the perpendicular bisector is the exact same distance (equidistant) from the two endpoints of the original segment. We will learn the classic compass-and-straightedge method to construct this important line.

Sub-concepts to be covered

1. **Definition of a Perpendicular Bisector:** A line, ray, or segment that is perpendicular to a given segment at its midpoint.
2. **The Equidistant Property:** Every point on the perpendicular bisector of a segment is equidistant from the endpoints of the segment.
3. **Steps for Construction using a Compass and Ruler:** This is a core construction that does not require a protractor.

Steps to Construct Points Equidistant from Two Given Points:

Let's say you are given two points A and B, and you need to construct a point P that is equidistant from both A and B.

Step-by-Step Construction

1. **Draw the Line Segment AB:** Start by drawing a line segment AB using a ruler. Label the points A and B.

Fig. 8.39

2. **Find the Midpoint of AB**
   - To find the midpoint of line segment AB, measure the length of AB with a ruler and divide it by 2. Mark this point as M.
   - Alternatively, use a compass to measure equal lengths from A and B along the segment and mark where the compass arcs intersect.

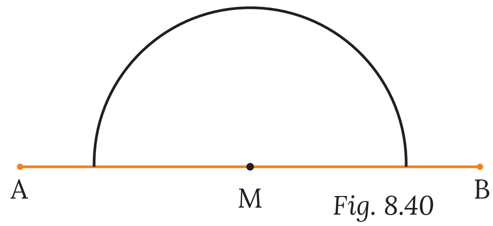


Fig. 8.40

3. **Draw the Perpendicular Bisector of AB**
   - Place the compass pointer at A and adjust the compass width to be more than half the length of AB.
   - With the compass, draw arcs above and below the line AB. Without changing the compass width, repeat this step from point B.
   - Mark the points where the arcs intersect above and below the line.
   - Using a ruler, draw a straight line through these intersection points. This is the perpendicular bisector of AB, and it intersects AB at point M, the midpoint of AB.

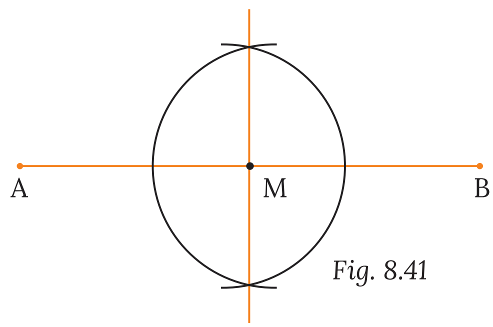


Fig. 8.41

4. **Choose Any Point on the Perpendicular Bisector**
   - Any point on the perpendicular bisector (other than the midpoint M) will be equidistant from A and B.
   - You can choose any point P along this perpendicular bisector, and the distance from P to A will be the same as the distance from P to B.

5. **Verification:** Use a compass to check that the distance from P to A is equal to the distance from P to B.

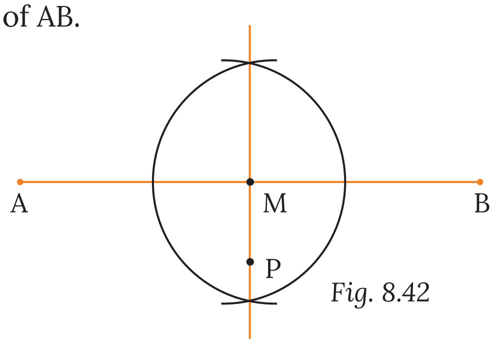


Fig. 8.42

Example 7 : Construct a rectangle of sides 14 cm and 8 cm, and a square inside it, such that the center of the square is the same as the center of the rectangle.

Solution Steps:

Step 1: Draw the Rectangle

Draw a line segment AB of 14 cm to represent one side of the rectangle.

Fig. 8.43

Step 2: Draw a 90° Angle

At point A, draw an angle of 90° using a protractor to set the direction for the per pendicular sides of the rectangle.

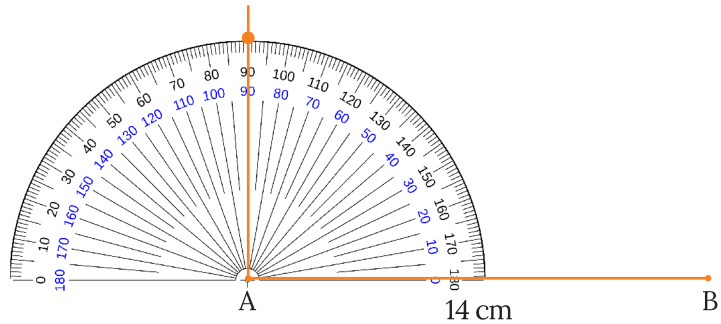


Fig. 8.44

Step 3: Mark Point D

From point A, draw an arc with a radius of 8 cm (the shorter side of the rectangle). The arc should intersect the 90° angle at a new point, labeled D. **(Fig. 8.45)**

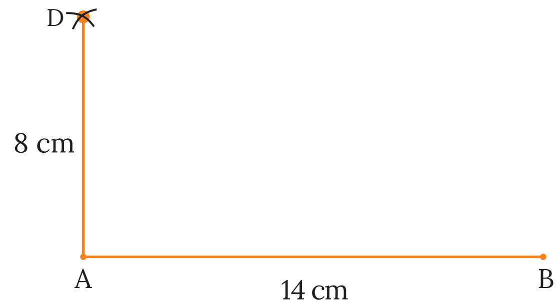


Fig. 8.45

Step 4: Draw Side BC

Now, use the same 8 cm radius and center at point B, to draw another arc, and mark the intersection as C. This step ensures the shorter side of the rectangle is properly positioned. **(Fig. 8.46)**

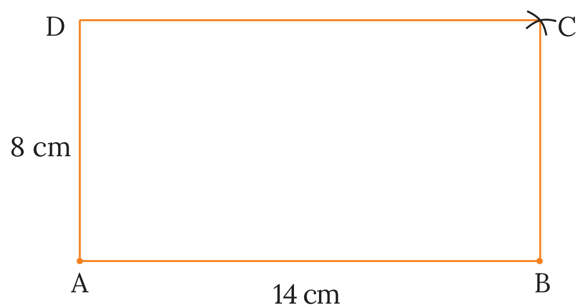


Fig. 8.46

Step 5: Construct the Square inside the Rectangle

The center of the square must coincide with the center of the rectangle. To do this:

Measure the midpoints of the sides of the rectangle.

Draw diagonals inside the rectangle to find the center of the rectangle. **(Fig. 8.47)**

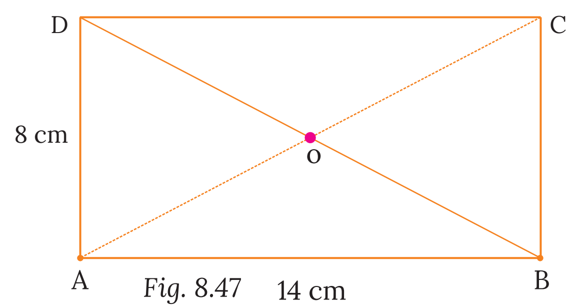


Fig. 8.47

Draw a horizontal line passing through O and parallel to AB and CD.

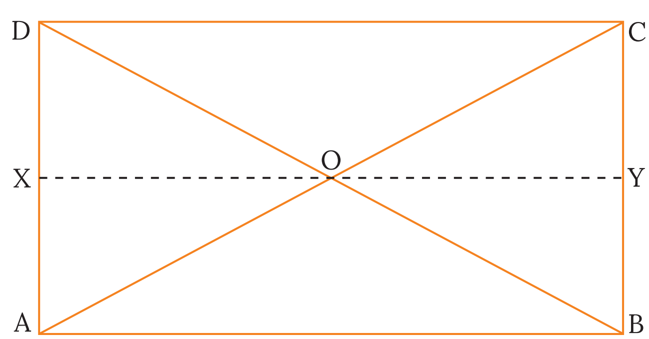


Fig. 8.48

Draw perpendicular bisector of OX and OY. Open the compass more than half of the length of OX and draw arcs above and below the line OX, from points O and X both and join the arcs.

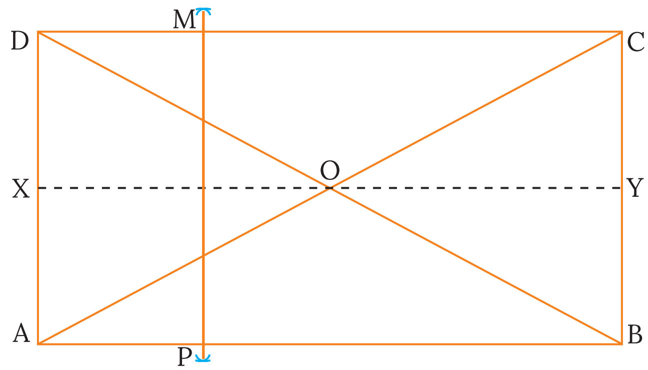


Fig. 8.49

Follow same steps for line OY.

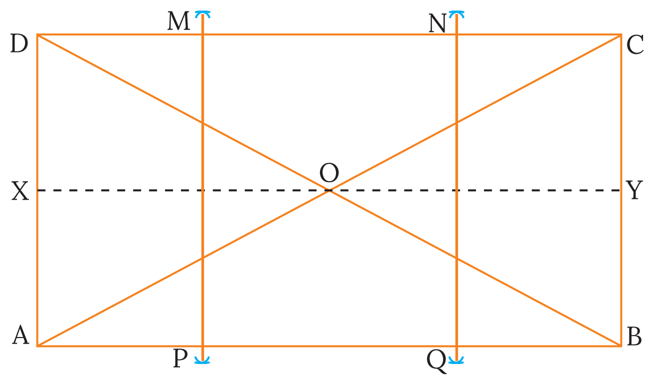


Fig. 8.50

Resultant, PQMN is the square with side 4 cm and same center as the rectangle.

Example 8 : Points A and B are 6 cm apart. Point P lies on the perpendicular bisector of AB. What can you say about the distance of P from points A and B?

Solution: Since P lies on the perpendicular bisector of AB, PA = PB

Example 9 : Line segment XY is 8 cm long. Point M is the midpoint. A perpendicular line is drawn at M. Point Q lies on this line, 3 cm above XY. What is the distance from Q to X and Q to Y?

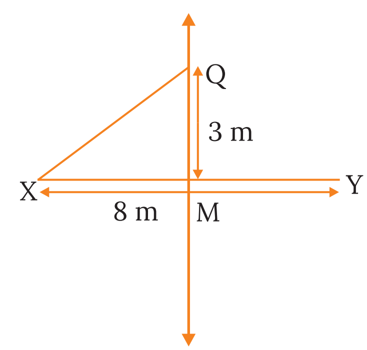


Fig. 8.51

Solution: M is the midpoint, so XM = MY = 4 cm

Using the Pythagoras Theorem:

Distance from Q to X = $\sqrt{4^4 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5\,\text{cm}$

Q is equidistant from X and Y, so QX = QY = 5 cm

Example 10 : Two points C and D are 10 cm apart. A point R is 6 cm from both C and D. Can we say it lies on the perpendicular bisector of CD?

Solution: Since R is 6 cm from both C and D,

So, yes it must lie on the perpendicular bisector of CD.

Example 11 : A line segment EF is 12 cm long. Point G lies on the perpendicular bisector of EF. If GE = 10 cm, what is GF?

Solution: Since G lies on the perpendicular bisector,

GE = GF = 10 cm

Knowledge Checkpoint

1. What is the most important rule about the compass width when constructing a perpendicular bisector?
2. What two things does a perpendicular bisector do to a line segment?
3. Can you construct a perpendicular bisector using a protractor? (You can draw one, but the classic construction uses only a compass).

Activity

Paper Folding Bisector

Objective: To create a perpendicular bisector by folding.

Materials: A sheet of paper, a ruler.

Procedure:

- ♦ Draw a line segment AB on the paper.
- ♦ Carefully fold the paper so that point A lands exactly on top of point B.
- ♦ Make a sharp crease.
- ♦ Unfold the paper. The crease is the perpendicular bisector of the segment AB.

- **Inquiry:** Use a ruler and protractor to verify. Does the crease pass through the midpoint of AB? Does it form a 90° angle with AB? Why does this folding method work? (Because you are forcing all points on the crease to be equidistant from A and B).

Key Terms

- **Perpendicular Bisector:** A line that divides a line segment into two equal parts at a 90° angle.
- **Midpoint:** The point that is exactly halfway along a line segment.
- **Equidistant:** Being at an equal distance from two or more points.
- **Chord:** A line segment connecting any two points on a circle's circumference.

Do It Yourself

You are given a line L and a point P not on the line. Can you use the principles of the perpendicular bisector construction to construct a new line that passes through P and is perpendicular to L? How would you do it?

Facts Flash

a) The perpendicular bisectors of the three sides of any triangle always meet at a single point. This point is the center of a circle (the "**circumcircle**") that can be drawn to pass through all three vertices of the triangle.

b) This construction allows you to create a right angle anywhere, which is a key step in constructing a square without a protractor.

Mental Mathematics

- A line segment is 14 cm long. Its midpoint is at what mark?
- A line is perpendicular to another. What is the angle between them?
- If a point is 5 cm from point A and 5 cm from point B, it must lie on the ....
- You bisect a 12 cm line segment. How long are the two new segments?

Gap Analyzer™ Homework

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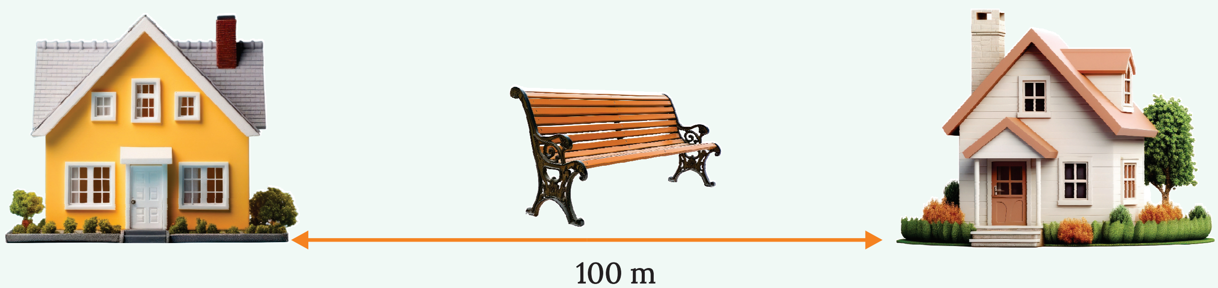
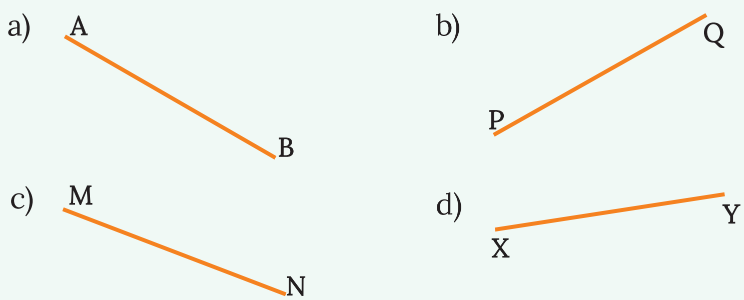
Exercise 8.4

1. You are building a frame for a traditional kite. The main vertical stick is 50 cm long. The horizontal stick is 30 cm long and must be attached perpendicularly to the main stick at a point 15 cm from the top. Using a scale of 1 cm = 5 cm, construct the frame of the kite.
2. Two friends live in houses that are 100 meters apart on the same side of a straight road. They want to place a bench on the roadside exactly halfway between their two houses. How much will be the distance between the bench and their houses. Draw a perpendicular line to mark the place for the bench. Use the scale of 10 m = 1 cm,



3. **For the given line segments, construct their perpendicular bisectors.**

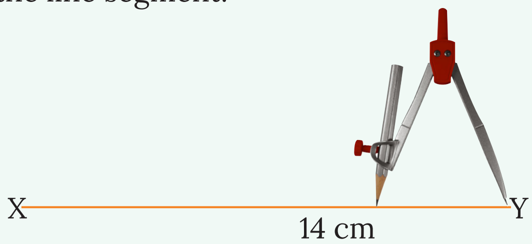


4. Draw a circle of radius 4 cm, such that its centre lies on the point where perpendicular bisector of AB intersects it. Take length of line segment AB as 10 cm.
5. **Fill in the blanks:**
   a) The perpendicular bisector of a line segment divides it into ___________ equal parts.
   b) If a point lies on the perpendicular bisector of a line segment, it is ___________ from both endpoints of the segment.
   c) The angle formed between a line segment and its perpendicular bisector is ___________.
   d) The perpendicular bisector of a line segment always passes through its ___________.

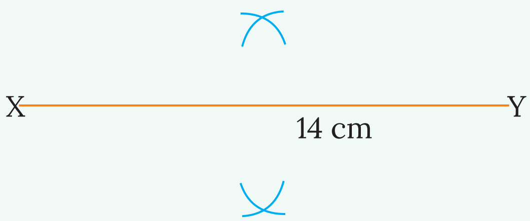
6. Which of the following steps is wrong in the process of constructing a perpendicular bisector?

Step 1: Draw the line segment.

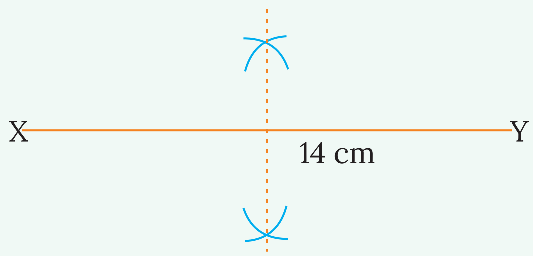
Step 2: Open the compass, exactly midway of the line segment.



Step 3: Mark the arcs above and below the line segment from points X and y both.



Step 4: Join both the intersections.



Common Misconceptions

Misconception: A square is not a rectangle

Correction: A square is actually a special type of rectangle. A rectangle is defined as a quadrilateral with four right angles. A square fits this definition perfectly. It just has the additional property that all its sides are also equal. So, all squares are rectangles, but not all rectangles are squares.

Misconception: The diagonals of a rectangle are always perpendicular.

Correction: This is only true if the rectangle is a square. For any other rectangle, the diagonals are equal in length and bisect each other, but they do not meet at a 90° angle. You can easily check this by drawing a long, thin rectangle and its diagonals—the angles at the intersection will be clearly acute and obtuse, not right angles.

Misconception: To construct a perpendicular bisector, you can set the compass to any width.

Correction: The compass width must be more than half the length of the line segment. If it's too short, the arcs you draw from each endpoint will not intersect, and you won't be able to find the points needed to draw the bisector line.

Real-Life Constructions: Mathematical Applications

Here's how creating accurate shapes with a compass and ruler is used in professional fields:

- **Architecture and Engineering:** Blueprints for buildings rely on precise constructions. Architects must draw perfect 90° angles for corners and use perpendicular bisectors to find the center point for a supportive arch or dome.
- **Design and Art:** From company logos to intricate Rangoli patterns, designers use constructions for symmetry. An angle bisector helps create a perfectly mirrored image, while concentric circles form the basis of a mandala.
- **Carpentry and Manufacturing:** A carpenter might use the construction of a perpendicular bisector to find the exact center of a circular tabletop before attaching its legs, ensuring perfect balance.
- **Navigation and Mapping:** Land surveyors use these geometric principles to divide property, plan roads, and create accurate maps, ensuring all boundaries are marked with precision.

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EXERCISE

A. Choose the correct answer.

1. Which tool is essential for drawing a circle of a specific radius?
   a) Protractor ☐ b) Ruler ☐ c) Compass ☐ d) Set-square ☐
2. The diagonals of a rectangle are always:
   a) Perpendicular ☐ b) Equal to the sides ☐
   c) Unequal ☐ d) Equal in length ☐
3. To construct a square with a side of 5 cm, the first step is to:
   a) Draw a 5 cm line segment ☐ b) Draw a circle of 5 cm radius ☐
   c) Set the compass to 5 cm ☐ d) Draw a 90° angle ☐
4. A perpendicular bisector cuts a line segment at what angle?
   a) 45° ☐ b) 60° ☐ c) 90° ☐ d) 180° ☐
5. If the diameter of a circle is 12 cm, its radius is:
   a) 24 cm ☐ b) 12 cm ☐ c) 6 cm ☐ d) 4 cm ☐

Assertion & Reason

In each of the following questions, an Assertion (A) and a corresponding Reason (R) supporting it is given.

Study both the statements and state which of the following is correct:

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

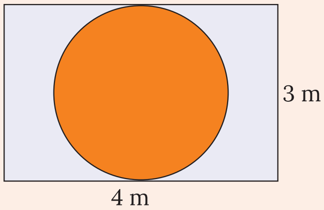
d) A is false but R is true.

1. **Assertion (A):** The diagonals of a square are perpendicular to each other.
   Reason (R): All squares are also rectangles, and the diagonals of a rectangles are perpendicular.
2. **Assertion (A):** To draw a circle of diameter 8 cm, the compass should be set to 8 cm.
   Reason (R): The compass setting is equal to the radius of the circle.
3. **Assertion (A):** A perpendicular bisector can be constructed for any straight line.
   Reason (R): A straight line extends infinitely, so it does not have a midpoint to bisect.

Case Study

An interior designer is planning a feature wall. The wall is rectangular, 4 meters wide and 3 meters high. She wants to paint a large circle in the middle that just touches the top and bottom of the wall.

1. What is the diameter of the largest circle she can paint?
2. What is its radius?
3. Where will the center of this circle be located on the wall?
4. Construct a scaled diagram of the wall and the circle.



Project

Blueprint for a Dream Clubhouse

Objective: To apply all the construction skills learned in this chapter to a practical design project.

Scenario: Your friends have decided to build a small, one-room clubhouse in a backyard. You are the head architect, and you need to create the official blueprint.

Requirements for the Blueprint (to be drawn on A3/chart paper):

1. **The Clubhouse Floor:** The clubhouse must be a rectangle with dimensions 6 meters by 4 meters.
2. **The Door:** There is one door, 1 meter wide. It must be placed exactly in the middle of one of the 6-meter walls.
3. **The Windows:** There are two square windows, each with a side length of 1 meter. They must be placed on the 4-meter walls, centered on the wall.
4. **The Central Table:** A circular table with a diameter of 2 meters is located at the exact center of the room.
5. **The Rug:** A square rug with a diagonal of 2 meters is placed under the table, with its corners pointing towards the walls.

Your Task:

1. **Choose a Scale:** Decide on a suitable scale for your drawing (e.g., 1 meter = 5 cm or 1 meter = 4 cm). State your scale clearly on the blueprint.
2. **Construct, Don't Sketch:** Use your ruler, compass, and protractor to construct the blueprint with perfect accuracy based on the requirements.
   - Construct the main rectangular floor.
   - Use the perpendicular bisector method to find the exact center of the walls for the door and windows, and the center of the room for the table.
   - Construct the circular table.
   - Construct the square rug using its diagonal length.
3. **Label Everything:** Label all parts of your blueprint (walls, door, windows, table, rug) and write down their real-life dimensions.
4. **Submit:** Your final, neat, and accurate blueprint.

Source-Based Question

Carrom Board: Size and Dimensions

Carrom is a popular indoor game enjoyed by people of all ages. The carrom board size plays an important role in how smoothly the game is played, affecting striker movement and pocketing accuracy. While professional tournaments use a standard carrom board size, casual players often prefer different sizes based on their comfort and playing space. Smaller boards are common for beginners, while larger ones may be used for recreational play.

Choosing the right board depends on factors like skill level and space availability. The standard size of carrom board ensures a consistent playing experience, making it ideal for serious players. For home use, non-standard sizes offer more flexibility and are often easier to manage. A well-sized board improves gameplay by providing proper rebounds and a smooth playing surface. Understanding these variations helps players select the right board for their needs.

Standard Carrom Board Size and Dimensions

Carrom boards come in different sizes, but for professional and tournament play, there is a standard size that players and manufacturers follow. The dimensions of the board affect the game's difficulty, precision, and overall experience. Whether you're a casual player or a professional, understanding the standard size helps in choosing a board that meets your requirements.

Official Size

The standard carrom board, as approved by the International Carrom Federation (ICF), measures 74 cm x 74 cm (29 inches x 29 inches). This size is used in official tournaments and professional matches.

Frame Width

The wooden frame surrounding the playing surface is 5 cm to 7.5 cm (2 inches to 3 inches) wide, providing the required rebound effect for smooth gameplay.

Playing Surface

The inner playing area, excluding the border, is 73.5 cm x 73.5 cm (28.9 inches x 28.9 inches). This ensures consistent playing conditions for all levels of players.

Board Thickness

The thickness of a high-quality carrom board typically ranges from 8 mm to 12 mm (0.3 inches to 0.5 inches). A thicker board prevents bending and ensures durability over time.

Pocket Size

Each pocket has a diameter of 4.45 cm (1.75 inches), allowing the carrom men and striker to pass through smoothly.

Non-Standard Sizes

Apart from the official tournament size, other variations are available. Larger boards around 85 cm x 85 cm are used in clubs, while medium-sized boards of 67 cm x 67 cm are preferred for casual home play. Smaller boards, typically 50 cm x 50 cm, are designed for kids and beginners.

Different Types of Carrom Boards

Carrom boards come in various types, each designed for different levels of play. From casual home games to professional tournaments, the type of board used can significantly impact the playing experience. Understanding these variations helps in selecting a board that suits your needs.

Type of Carrom Board	Playing Surface	Frame Width	Best Suited For
Standard Tournament Carrom Board	74 cm × 74 cm	5 cm – 7.5 cm	Professionals, official competitions
Club-Level Carrom Board	78 cm × 78 cm	6 cm – 8 cm	Serious players, regular club practice
Home-Use Carrom Board	60 cm – 67 cm	4 cm – 6 cm	Families, casual/recreational play
Small-Sized (Kids' Carrom Board)	50 cm – 60 cm	Not specified	Young players, beginners
Jumbo / Large-Sized Carrom Board	85 cm × 85 cm or larger	Not specified	Experienced players, clubs, recreation

Source Text: **Adapted from Precise Sports article, Carrom Board Size and Dimensions**

Questions on the data:

1. What will be the length of the diagonal of the carrom board used in Standard Tournament?
2. Will the length of both diagonals same different?
3. Considering the side of a home-use carrom board to be 60 cm, what will be the length of both its diagonals?
4. If the central circle (queen spot) is at the intersection of the diagonals of home-use carrom board with side 60 cm, where exactly is it located in terms of distance from the corners?

Mind Map

Playing With Constructions

Construction in Mathematics

- Tools used (scale, compass, protractor etc.)

Circle

- Drawing a circle using compass
- Understanding center and radius
- Terms: chord, diameter, arc, sector

More on Constructions

- Constructing a Perpendicular Bisector

Squares and Rectangles

- Properties of squares and rectangles (sides, angles)
- Steps to Construct a Square.
- Steps to Construct a Rectangle.

Property		Rectangle	Square
Sides	All Sides are equal	✗	✓
	Opposite Sides are equal	✓	✓
	Opposite Sides are parallel	✓	✓
Angles	All angles are equal	✓	✓
	Opposite angles are equal	✓	✓
	Sum of two adjacent angles is 180	✓	✓
Diagonals	Bisect each other	✓	✓
	Bisect perpendicularly	✗	✓

Exploring Diagonals of Rectangles and Squares

- Drawing diagonals
- Properties of diagonals (length, intersection)