

# 6) In The Following Rectangle ABCD, The Sum Of The Lengths Of AB, BC, And CD Is 90 Cm. The sum Of The

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## Introduction

In the realm of geometry, rectangles are fundamental shapes that serve as the building blocks for understanding more complex figures. They are characterized by their four right angles and opposite sides that are equal in length. Problems involving rectangles often require calculating specific side lengths, understanding relationships between the sides, or applying geometric formulas to solve for unknowns.

The problem at hand involves a rectangle labeled ABCD, with a given sum of three consecutive sides—AB, BC, and CD—equal to 90 centimeters. This type of problem is common in geometry exercises designed to test understanding of properties of rectangles, algebraic reasoning, and problem-solving skills.

Understanding how to approach such problems requires a clear grasp of the properties of rectangles, how to set up algebraic equations based on given information, and how to manipulate those equations to find unknown lengths. This article aims to provide a comprehensive explanation of the problem, explore relevant concepts, and demonstrate step-by-step solutions, all while optimizing for clarity and search engine visibility.

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## Understanding the Geometry of Rectangle ABCD

### Properties of a Rectangle

Before delving into the problem, it's essential to review the key properties of a rectangle:

- Opposite sides are equal:  $AB = CD$  and  $BC = AD$ .
- All angles are right angles ( $90^\circ$ ).
- Diagonals are equal in length and bisect each other.

In rectangle ABCD:

- Side AB is adjacent to sides BC and AD.
- Side BC is adjacent to sides AB and CD.
- Side CD is adjacent to sides BC and DA.

- Side DA is adjacent to sides AB and CD.

Typical notation:

- AB and CD are horizontal sides.
- BC and DA are vertical sides.

Assumptions in the problem

The problem states that the sum of the lengths of AB, BC, and CD is 90 cm. Specifically:

- AB (top side)
- BC (right side)
- CD (bottom side)

Given the properties of rectangles, the following relationships are true:

- $AB = CD$
- $BC = DA$

Because ABCD is a rectangle, sides AB and CD are equal, and sides BC and DA are equal.

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Analyzing the Given Data

The sum of three sides:

$$> AB + BC + CD = 90 \text{ cm}$$

Since  $AB = CD$ , we can substitute:

$$> AB + BC + AB = 90 \text{ cm}$$

Simplifying:

$$> 2 AB + BC = 90 \text{ cm}$$

This relation forms the basis for further calculations.

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Step-by-Step Solution Approach

Step 1: Define Variables

Let:

- $x$  = length of side AB (and CD)

-  $y$  = length of side BC (and DA)

From the properties of rectangles, the sides AB and CD are equal, and BC and DA are equal.

Step 2: Set Up the Equation

Using the given sum:

$$> AB + BC + CD = 90 \text{ cm}$$

Substitute  $x$  and  $y$ :

$$> x + y + x = 90 \text{ cm}$$

Simplify:

$$> 2x + y = 90 \text{ cm}$$

This is the main equation to work with.

Step 3: Express One Variable in Terms of the Other

From the equation:

$$> 2x + y = 90 \text{ cm}$$

Express  $y$  in terms of  $x$ :

$$> y = 90 - 2x$$

Step 4: Consider Additional Constraints

Since the lengths of sides must be positive:

- $x > 0$
- $y > 0$

Substitute  $y$ :

$$> 90 - 2x > 0$$

Solve for  $x$ :

$$> 2x < 90$$

$$> x < 45 \text{ cm}$$

Similarly, since  $y = 90 - 2x > 0$ :

$$> 90 - 2x > 0$$

which is the same as above, confirming that:

$$0 < x < 45 \text{ cm}$$

#### Step 5: Find Possible Side Lengths

Given  $x$  can vary between just above 0 and just below 45 cm, the side lengths are flexible within these bounds. For specific solutions, additional information is needed, such as the length of a diagonal or the perimeter.

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#### Additional Problems and Solutions

##### 1. Calculating the Length of Diagonals

Knowing the side lengths, we can find the length of the diagonal using the Pythagorean theorem.

$$\text{Diagonal } d = \sqrt{x^2 + y^2}$$

Substitute  $y$ :

$$d = \sqrt{x^2 + (90 - 2x)^2}$$

##### 2. Finding Exact Lengths When Diagonals Are Given

Suppose the diagonal is specified to be a certain length, say 100 cm, then:

$$\sqrt{x^2 + (90 - 2x)^2} = 100$$

Square both sides:

$$x^2 + (90 - 2x)^2 = 10,000$$

Expand:

$$x^2 + (8100 - 360x + 4x^2) = 10,000$$

Simplify:

$$x^2 + 8100 - 360x + 4x^2 = 10,000$$

Combine like terms:

$$5x^2 - 360x + 8100 = 10,000$$

Bring all to one side:

$$5x^2 - 360x + 8100 - 10,000 = 0$$

$$> \ ( 5x^2 - 360x - 1900 = 0 \ )$$

Divide through by 5:

$$> \ ( x^2 - 72x - 380 = 0 \ )$$

Use quadratic formula:

$$> \ ( x = \frac{72 \pm \sqrt{72^2 - 4 \times 1 \times (-380)}}{2} \ )$$

Calculate discriminant:

$$> \ ( \sqrt{5184 + 1520} = \sqrt{6704} \ )$$

Approximate:

$$> \ ( \sqrt{6704} \approx 81.86 \ )$$

Calculate x:

$$> \ ( x = \frac{72 \pm 81.86}{2} \ )$$

Two solutions:

- $( x = \frac{72 + 81.86}{2} \approx \frac{153.86}{2} \approx 76.93 \ )$  cm  
(not feasible since  $x < 45$  cm)
- $( x = \frac{72 - 81.86}{2} \approx \frac{-9.86}{2} \approx -4.93 \ )$  cm  
(not feasible)

Thus, with a diagonal of 100 cm, no feasible solutions exist within the constraints.

### 3. Practical Applications

Understanding how to manipulate side lengths based on given sums helps in various real-world scenarios such as:

- Designing rectangular plots with specific boundary lengths
- Calculating materials needed for construction
- Engineering applications involving rectangular components

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### Visualizing the Problem

A diagram helps clarify the relationships:

...

```
+-----+ AB = x
| |
| |
```

```

AD = y |
| |
| |
+-----+ CD = x
\ \

```

Where:

- $AB = x$
- $BC = y$
- $CD = x$
- $DA = y$

Given the problem, the sum  $AB + BC + CD = 90$  cm is visually represented, emphasizing the relationship between the sides.

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### Summary and Key Takeaways

- In a rectangle ABCD, opposite sides are equal:  $AB = CD$  and  $BC = DA$ .
- The sum of three sides AB, BC, and CD is given as 90 cm.
- Using algebra, we set  $x = AB = CD$  and  $y = BC = DA$ .
- The main equation derived:  $(2x + y = 90)$ .
- The side lengths are constrained by positivity:  $(0 < x < 45)$  cm and  $(y = 90 - 2x)$ .
- Additional information, such as diagonal length, can help determine exact side measurements.
- Understanding these relationships is crucial for solving geometric problems involving rectangles.

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### Conclusion

Problems involving rectangles with given side sums are foundational in geometry, helping to develop algebraic reasoning and an understanding of shape properties. By systematically defining variables, setting up equations, and applying geometric principles, students can solve for unknown lengths with confidence.

The key to tackling such problems lies in recognizing the properties of rectangles, translating word problems into algebraic equations, and applying mathematical techniques effectively. Whether for academic purposes or real-world applications, mastering these concepts enhances spatial reasoning and problem-solving skills.

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Keywords for SEO Optimization

- Rectangle ABCD problem
- Side lengths of rectangle
- Geometric problem solving
- Algebra in geometry
- Rectangle side relationships
- Length calculation in rectangles
- Pythagorean theorem in rectangles
- Solving for side lengths
- Geometry exercises
- Mathematical problem solutions

## Frequently Asked Questions

**In rectangle ABCD, if the sum of lengths AB, BC, and CD is 90 cm, what is the length of AD?**

Since ABCD is a rectangle, AB is equal to DC and BC is equal to AD. Given that  $AB + BC + CD = 90$  cm, and  $AB = DC$ ,  $CD = AB$ , and  $BC = AD$ , the sum becomes  $AB + BC + AB = 90$  cm, or  $2AB + BC = 90$  cm. Without additional information, the length of AD (which equals BC) cannot be determined precisely.

**How can knowing that ABCD is a rectangle help in solving for the individual side lengths given the sum of three sides?**

In a rectangle, opposite sides are equal, so  $AB = DC$  and  $BC = AD$ . If the sum of AB, BC, and CD is known, and since  $CD = AB$ , you can set up equations to find individual lengths. For example, if  $AB = x$  and  $BC = y$ , then  $2x + y = 90$  cm, allowing you to determine possible side lengths if additional information is provided.

**What additional data is needed to find the exact lengths of sides AB, BC, and CD in the rectangle?**

To find the exact lengths, we need either the length of one side or the measure of the diagonal, or another relationship between sides, such as the area or the length of AD, to solve the system of equations completely.

**If in rectangle ABCD, the length of AB is equal to the length of CD, and the sum of AB, BC, and CD is 90 cm, what are possible values for AB and BC?**

Since  $AB = CD$ , the sum becomes  $AB + BC + AB = 2AB + BC = 90$  cm. If we assume  $AB = x$  and  $BC = y$ , then  $2x + y = 90$  cm. Possible pairs include  $(x, y) = (30 \text{ cm}, 30 \text{ cm})$ ,  $(20 \text{ cm}, 50 \text{ cm})$ , etc., as long as they satisfy the equation.

## Can the length of side BC be greater than 45 cm given the sum of AB, BC, and CD is 90 cm?

Yes. Since AB and CD are equal, and their sum along with BC is 90 cm, BC can be greater than 45 cm if AB (or CD) is less than 22.5 cm. For example, if AB = 20 cm, then  $20 + BC = 90$  cm, so  $BC = 70$  cm, which is greater than 45 cm.

## What geometric principles can be used to solve for the individual side lengths in this rectangle problem?

Using the properties of rectangles—opposite sides are equal—and setting up algebraic equations based on the given sum allows solving for individual lengths. Additional principles like the Pythagorean theorem may be applied if diagonals or angles are involved.

## Additional Resources

In The Following Rectangle ABCD, The Sum Of The Lengths Of AB, BC, And CD Is 90 Cm. The Sum Of The

Understanding the properties and calculations related to rectangles is fundamental in geometry, especially when dealing with real-world applications such as construction, design, and various engineering problems. The statement involving rectangle ABCD, where the sum of three sides is given, opens up a range of mathematical explorations—from basic perimeter calculations to more complex geometric reasoning. This article aims to provide a comprehensive review of this problem, delving into the concepts, methods, and implications involved in analyzing rectangles with given side sums.

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## Understanding the Problem and Its Geometric Context

The problem states: In the following rectangle ABCD, the sum of the lengths of AB, BC, and CD is 90 cm. At first glance, this appears straightforward, but it invites questions about the properties of rectangles, the relationship between their sides, and how to interpret the given sum.

In a rectangle ABCD, the sides are typically labeled so that AB is opposite to CD, and BC is opposite to AD. The key properties include:

- Opposite sides are equal in length:  $AB = CD$  and  $BC = AD$ .
- All angles are right angles (90 degrees).

Given the sum of AB, BC, and CD, and knowing the properties of a rectangle,

we can analyze the problem to determine unknown side lengths, perimeters, and other relevant measurements.

Important Clarification:

The statement mentions the sum of AB, BC, and CD. Since in a rectangle, AB and CD are equal, and BC and AD are equal, the sum includes a repeated side if the sides are considered distinctly. To clarify, if the sum is  $AB + BC + CD$ , then:

- $AB = CD$
- $BC = AD$

Thus, the sum  $AB + BC + CD$  can be rewritten as:  
 $AB + BC + AB = 2AB + BC$ .

This interpretation is key to solving the problem accurately.

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## Mathematical Formulation and Approach

### Setting Up Variables and Equations

Let:

- $AB = x \text{ cm}$
- $BC = y \text{ cm}$

Since ABCD is a rectangle:

- $CD = x \text{ cm}$  (opposite to AB)
- $AD = y \text{ cm}$  (opposite to BC)

Given the sum:

$AB + BC + CD = 90 \text{ cm}$ , which simplifies to:

$$x + y + x = 90$$

$$2x + y = 90$$

This is the primary equation to work with.

### Additional Constraints and Considerations

Because ABCD is a rectangle:

- The sides are perpendicular, but this doesn't directly affect the side lengths unless more information is provided.

If the problem involves finding specific side lengths or the perimeter, the following steps are relevant:

- Expressing all sides in terms of variables and knowns.
- Using the given sum to find relationships between  $x$  and  $y$ .
- If the problem involves optimizing or calculating area, further relationships are needed.

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## Solving for Side Lengths and Perimeter

Given the primary equation:

$$2x + y = 90$$

Suppose the task is to determine possible values of  $x$  and  $y$ .

- Since side lengths are positive,
- $x > 0$ ,  $y > 0$ .

Express  $y$  in terms of  $x$ :

$$y = 90 - 2x$$

To ensure  $y > 0$ :

$$90 - 2x > 0$$

$$2x < 90$$

$$x < 45$$

Similarly, since  $x > 0$ :

$$x > 0$$

Thus,  $x$  can vary between 0 and 45 cm.

Calculating the Perimeter

The perimeter  $P$  of rectangle ABCD is:

$$P = 2(AB + BC) = 2(x + y)$$

Substitute  $y$ :

$$P = 2(x + 90 - 2x) = 2(90 - x) = 180 - 2x$$

Since  $x$  varies between 0 and 45, perimeter  $P$  varies between:

- For  $x$  approaching 0:  $P \approx 180 - 0 = 180$  cm
- For  $x$  approaching 45:  $P \approx 180 - 90 = 90$  cm

This indicates that the perimeter decreases as  $x$  increases within the permissible range.

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## Implications and Additional Calculations

Area of the Rectangle

The area  $A$  is:

$$A = AB \times BC = x \times y = x(90 - 2x)$$

Expressed as a quadratic:

$$A = 90x - 2x^2$$

To find the maximum area, differentiate with respect to  $x$  and set to zero:

$$dA/dx = 90 - 4x = 0$$

$$4x = 90$$

$$x = 22.5 \text{ cm}$$

Correspondingly,  $y$ :

$$y = 90 - 2(22.5) = 90 - 45 = 45 \text{ cm}$$

Thus, the maximum area is:

$$A_{\text{max}} = 22.5 \times 45 = 1012.5 \text{ cm}^2$$

Features of the Solution:

- The maximum area occurs when  $x = 22.5 \text{ cm}$  and  $y = 45 \text{ cm}$ .
- The rectangle dimensions at maximum area are:  $AB = 22.5 \text{ cm}$ ,  $BC = 45 \text{ cm}$ .

Practical Implications:

Knowing the side lengths allows for precise construction or design work, such as creating rectangular plots, frames, or other structures with specified side sum constraints.

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## Real-World Applications and Examples

### Construction and Design

In construction, having constraints like the sum of certain sides can help in designing structures or components that fit specific dimensions. For example, if a builder has a fixed amount of material (say, 90 cm for three sides), understanding the possible dimensions of a rectangle that can be formed is crucial.

### Engineering and Manufacturing

Manufacturers often need to optimize material usage while adhering to size constraints. Using the relationships derived, they can determine the maximum area or the most efficient dimensions within given limits.

### Educational Use

Problems like these serve as excellent teaching tools for understanding the relationships between side lengths, perimeter, and area, as well as how to approach problems with algebraic and geometric reasoning.

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## Limitations and Assumptions in the Problem

While the analysis provides useful insights, some limitations and assumptions are inherent:

- The problem assumes the sides are positive and real numbers.
- It presumes the shape is a perfect rectangle with right angles.
- The problem interprets the sum of sides as per the given statement, assuming no typographical errors or ambiguities.
- When interpreting the sum ( $AB + BC + CD$ ), the assumption is that the sides are considered distinctly, and the sum does not include the fourth side explicitly unless specified.

Understanding these assumptions is essential for applying the derived formulas accurately in practical scenarios.

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## Conclusion and Summary

The problem involving rectangle ABCD and the sum of sides AB, BC, and CD being 90 cm offers a rich exploration of basic geometric principles and algebraic techniques. By setting variables, deriving relationships, and analyzing the resulting equations, we can determine possible side lengths, the maximum area, and the range of perimeters.

Key takeaways include:

- The importance of clear problem interpretation, especially regarding the sides involved.
- The utility of algebraic methods in solving geometric problems with constraints.
- How such problems have practical relevance in design, construction, and manufacturing.
- The value of understanding the interplay between side lengths, area, and perimeter for optimization purposes.

In essence, this problem exemplifies how fundamental geometry combined with algebra provides powerful tools for solving real-world and theoretical challenges, deepening our understanding of the properties and applications of rectangles.

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