A Student Takes A Rectangular Piece Of Paper 30 Cm Long And 21 Cm Wide Find The Area Of The Biggest Circle

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Understanding how to find the area of the largest possible circle that can be inscribed within a rectangle is a fundamental problem in geometry. In this article, we'll explore the step-by-step process to determine the area of the biggest circle that can fit inside a rectangular sheet measuring 30 cm in length and 21 cm in width. This problem not only enhances your understanding of circles and rectangles but also improves problem-solving skills in geometry.

Introduction to the Problem

Suppose a student has a rectangular sheet of paper with the following dimensions:

- Length = 30 cm
- Width = 21 cm

The goal is to find the area of the largest circle that can be inscribed within this rectangle. An inscribed circle is one that fits entirely within a shape, touching its sides without crossing them.

Understanding the Inscribed Circle

What is an Inscribed Circle?

An inscribed circle, also called an incircle, of a rectangle is a circle that touches all sides of the rectangle from inside. For a rectangle, the largest inscribed circle will be situated so that it touches two opposing sides and fits within the other two sides.

Key Properties of the Largest Inscribed Circle

- The circle touches the rectangle at exactly four points (one on each side).
- The diameter of the circle cannot be larger than the shortest side of the rectangle because it must fit entirely within the rectangle.

Determining the Diameter of the Largest Circle

Since the circle must fit within the rectangle, its diameter cannot exceed the shorter side of the rectangle.

Step 1: Identify the Shorter Side

- Length of rectangle = 30 cm
- Width of rectangle = 21 cm

The shortest side is 21 cm.

Step 2: Find the Diameter of the Largest Circle

- The diameter of the inscribed circle is equal to the length of the shorter side of the rectangle, which is 21 cm.

Step 3: Calculate the Radius

- Radius (r) = Diameter / 2
- r = 21 cm / 2 = 10.5 cm

Calculating the Area of the Largest Circle

The formula for the area (A) of a circle is:

$A = \pi r^2$

Where:
- π (pi) ≈ 3.1416
- r = radius of the circle

Step 4: Plug in the Radius

- $A = 3.1416 \times (10.5)^2$
- $A = 3.1416 \times 110.25$

Step 5: Perform the Calculation

- $A \approx 3.1416 \times 110.25 \approx 345.5754$ cm²

Therefore, the area of the biggest inscribed circle is approximately 345.58 square centimeters.

Summary of the Calculation

Step	Description	Calculation	Result
1	Identify shorter side	21 cm	-
2	Diameter of circle	Equal to shorter side	21 cm
3	Radius of circle	Diameter / 2	10.5 cm
4	Area of circle	$\pi \times r^2$	≈ 345.58 cm^2

Additional Considerations and Variations

While this solution applies directly to the problem at hand, it's useful to consider related scenarios and variations:

1. Largest Circle Inscribed in a Rectangle with Different Dimensions

- The method remains the same: the diameter of the inscribed circle equals the shortest side of the rectangle.

2. Inscribed Circle in a Square

- Since all sides are equal, the inscribed circle's diameter equals the side length of the square.

3. Largest Circle Inscribed in an Irregular Polygon

- More complex, involving advanced geometry or calculus to determine the incircle.

Practical Applications of Finding the Biggest Inscribed Circle

Understanding how to determine the largest inscribed circle has numerous practical applications:

- Design and Manufacturing: Ensuring components fit within specified dimensions.
- Architecture: Planning circular features within rectangular rooms or areas.
- Mathematics Education: Developing spatial reasoning and understanding geometric properties.
- Computer Graphics: Rendering inscribed circles within shapes for visual effects.

Conclusion

In summary, when a student is given a rectangular piece of paper measuring 30 cm by 21 cm, the

largest circle that can fit inside has a diameter equal to the shorter side, which is 21 cm. The area of this circle is approximately 345.58 square centimeters. This problem illustrates fundamental concepts in geometry, such as inscribed figures and the relationship between dimensions of shapes. Mastery of these principles is essential for students and professionals working in fields that require spatial reasoning and geometric calculations.

Key Takeaways

- The biggest inscribed circle in a rectangle touches all four sides.
- Its diameter is limited by the shortest side of the rectangle.
- Calculating the area involves finding the radius and applying the area formula for a circle.
- Practical applications span various fields, emphasizing the importance of understanding inscribed figures.

By understanding and applying these concepts, you can solve a wide range of geometric problems involving circles and rectangles, enhancing your problem-solving skills and geometric intuition.

Frequently Asked Questions

What is the maximum possible diameter of the circle that can be inscribed in a 30 cm by 21 cm rectangular paper?

The maximum diameter is equal to the length of the shorter side of the rectangle, which is 21 cm.

How do you calculate the area of the largest circle that can be inscribed in the rectangle?

First, find the diameter (which is the shorter side, 21 cm), then divide by 2 to get the radius (10.5 cm), and use the formula area = $\pi \times \text{radius}^2$.

What is the area of the biggest circle that can be inscribed in the paper?

The area is $\pi \times (10.5\text{ cm})^2 \approx 3.1416 \times 110.25 \approx 346.36$ square centimeters.

Why is the diameter of the circle limited by the shorter side of the rectangle?

Because the circle must fit entirely within the rectangle, its diameter cannot be longer than the shortest side; otherwise, it would extend beyond the rectangle's boundaries.

If the rectangle was rotated, would the maximum inscribed

circle's size change?

No, rotating the rectangle doesn't affect the maximum size of the inscribed circle, as it still depends on the shortest side, which remains 21 cm.

Additional Resources

Area of the Largest Possible Circle in a Rectangular Paper

When exploring geometric problems involving rectangles and circles, the relationship between shapes and their dimensions offers a fascinating insight into spatial reasoning and mathematical principles. In this detailed analysis, we examine a classic problem: A student takes a rectangular piece of paper measuring 30 cm in length and 21 cm in width. What is the area of the biggest possible circle that can be inscribed within this rectangle? This question not only encourages understanding of basic geometry but also demonstrates practical applications in design, manufacturing, and problem-solving scenarios.

Understanding the Problem: Basic Geometry Concepts

Before delving into calculations, it’s essential to understand the fundamental geometric principles involved:

- Rectangle Dimensions: The paper measures 30 cm (length) and 21 cm (width).
- Inscribed Circle: A circle that fits entirely within the rectangle, touching its sides but not extending beyond.

The core question is identifying the largest such circle that can be inscribed within the rectangle, and consequently, calculating its area.

Key Geometric Principles

The Largest Inscribed Circle

An inscribed circle within a rectangle is essentially the largest circle that fits entirely inside, touching the sides without crossing boundaries. The size of this circle depends on the rectangle’s dimensions:

- The circle’s diameter cannot be larger than the shortest side of the rectangle.
- The circle must be positioned such that it touches the rectangle’s sides without exceeding the boundary.

Determining the Diameter of the Largest Circle

Given the rectangle dimensions:

- Length (L) = 30 cm
- Width (W) = 21 cm

The largest circle that can be inscribed will have a diameter equal to the smaller of the two dimensions because:

- It cannot be longer than the shortest side; otherwise, it would protrude beyond the rectangle's boundary.
- Therefore, the maximum diameter of the inscribed circle is constrained by the width, which is 21 cm.

Positioning the Circle

Assuming the circle is centered within the rectangle, the maximum radius will be half of the diameter:

$$\text{Radius} (r) = \frac{\text{Diameter}}{2}$$

Since the diameter is limited by the shortest side (width), the maximum radius is:

$$r = \frac{21\, \text{cm}}{2} = 10.5\, \text{cm}$$

This positioning ensures the circle touches the two shorter sides (top and bottom) and remains within the longer sides (length).

Calculating the Area of the Largest Circle

Formula for the Area of a Circle

The area A of a circle with radius r is given by:

$$A = \pi r^2$$

Where:

- π (pi) ≈ 3.1416
- r is the radius of the circle

Applying the Dimensions

Using the maximum radius $r = 10.5\, \text{cm}$:

$$A = 3.1416 \times (10.5)^2$$

Calculating step-by-step:

1. Square the radius:

$$ (10.5)^2 = 110.25 $$

2. Multiply by π:

$$ A = 3.1416 \times 110.25 \approx 345.58\, \text{cm}^2 $$

Final Result

The area of the largest possible inscribed circle within the 30 cm by 21 cm rectangle is approximately 345.58 square centimeters.

Additional Considerations and Variations

While the primary solution involves inscribing the largest circle centered within the rectangle, several other factors and variations can be explored:

1. Off-Center Placement

- Impact: Moving the circle away from the center would reduce the maximum radius because the circle must still fit within the shorter side.
- Conclusion: Centered placement maximizes the radius, making it the optimal configuration.

2. Inscribing Multiple Circles

- Scenario: If the problem involved fitting multiple circles within the rectangle, the arrangement would depend on the sizes and the packing efficiency.
- Relevance: Useful in manufacturing processes where space optimization is crucial.

3. Inscribing Other Shapes

- Ellipses or Polygons: Similar principles could be applied to inscribe other shapes, but the calculations become more complex.

Practical Applications and Real-World Relevance

Understanding the maximum inscribed circle in a rectangle has tangible applications:

- Manufacturing: Designing circular components within rectangular sheets to minimize waste.
- Packaging: Ensuring that circular items fit within rectangular containers.
- Design and Art: Creating patterns or motifs that maximize circular areas within given boundaries.
- Engineering: Calculating the maximum size of circular parts that can be cut from rectangular materials.

Summary and Key Takeaways

- The largest circle inscribed within a rectangle is limited by the shortest side.
- For a 30 cm by 21 cm rectangle, the maximum inscribed circle has:

- Diameter = 21 cm (shorter side)
- Radius = 10.5 cm

- The area of this circle is approximately 345.58 cm^2.

- Positioning the circle at the center maximizes the radius and area.

Conclusion

This exploration underscores the elegance of geometric reasoning in solving practical problems. By understanding the constraints imposed by the rectangle's dimensions, we can confidently determine the maximum size of an inscribed circle and its area. Such insights not only enhance mathematical comprehension but also inform real-world applications where space optimization is essential.

In essence, the problem exemplifies how fundamental geometric principles can be applied to derive precise solutions, fostering a deeper appreciation of the interconnectedness of shapes and dimensions in everyday scenarios.

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