

One Cube Has Edge Length 2 Cm. A Larger Cube Has Edge Length 5 Cm. What Is The Ratio Of The Surface Area

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Understanding the relationship between the dimensions of geometric shapes and their surface areas is fundamental in geometry. When dealing with cubes, knowing how changes in edge length affect surface area can help in various real-world applications, such as packaging, manufacturing, and architecture. In this article, we will explore how to determine the ratio of the surface areas of two cubes when their edge lengths differ, specifically a smaller cube with an edge length of 2 cm and a larger cube with an edge length of 5 cm.

Introduction to Surface Area of Cubes

Before diving into the calculations, it's important to understand the basic properties of cubes:

- A cube has six faces, each of which is a square.
- The length of each edge of the cube is the same throughout.
- The surface area of a cube depends on the length of its edges.

The surface area (SA) of a cube is calculated using the formula:

$$SA = 6 \times (\text{Edge Length})^2$$

This formula arises because each face is a square with an area equal to the square of the edge length, and there are six such faces.

Calculating Surface Area of the Smaller Cube

Given:

- Edge length of smaller cube, $a = 2\text{ cm}$

Applying the surface area formula:

$$SA_{\text{small}} = 6 \times (2)^2 = 6 \times 4 = 24\text{ cm}^2$$

So, the surface area of the smaller cube is 24 square centimeters.

Calculating Surface Area of the Larger Cube

Given:

- Edge length of larger cube, $(b = 5\text{ cm})$

Applying the surface area formula:

$$SA_{\text{large}} = 6 \times (5)^2 = 6 \times 25 = 150\text{ cm}^2$$

The larger cube has a surface area of 150 square centimeters.

Understanding the Ratio of Surface Areas

The ratio of the surface areas of the smaller cube to the larger cube is expressed as:

$$\text{Ratio} = \frac{SA_{\text{small}}}{SA_{\text{large}}}$$

Substituting the calculated values:

$$\text{Ratio} = \frac{24}{150}$$

Simplifying the ratio:

$$\frac{24}{150} = \frac{12}{75} = \frac{4}{25}$$

Therefore, the ratio of the surface area of the smaller cube to that of the larger cube is 4:25.

Significance of the Ratio and Its Implications

Understanding this ratio is valuable because it illustrates how surface area scales with the size of the cube. Specifically, when the edge length increases, the surface area increases proportionally to the square of the edge length.

- For a cube with edge length (a) , the surface area is proportional to (a^2) .
- When the edge length increases from 2 cm to 5 cm, the ratio of their surface areas can be predicted by the square of the ratio of their edges.

Let's verify this:

$$\frac{b^2}{a^2} = \left(\frac{b}{a}\right)^2 = \left(\frac{5}{2}\right)^2 = \frac{25}{4}$$

which simplifies to 25:4, matching the inverse of our earlier ratio (since our ratio of surface areas is 4:25).

This confirms that as the edge length increases, the surface area increases by the square of the scale factor.

Practical Applications of Surface Area Ratios

Understanding surface area ratios has numerous practical implications:

- **Packaging and Material Usage:** When designing packaging boxes, knowing how surface area scales helps estimate the amount of material needed for different sizes.
- **Heat Transfer and Insulation:** Surface area affects heat exchange; larger surface areas mean more heat transfer, which is critical in engineering and environmental science.
- **Manufacturing and Cost Estimation:** Material costs are often related to surface area; understanding how size affects material requirements aids in budgeting.
- **Scaling in Architecture:** When scaling models or structures, understanding surface area ratios ensures accurate material and energy calculations.

Extended Example: Comparing Surface Area Ratios for Different Edge Lengths

Suppose you want to explore how the surface area changes when the edge length varies further. Let's consider a few examples:

Edge Length (cm)	Surface Area (cm ²)	Scale Factor (relative to 2 cm)
2	24	1
3	54	$\left(\frac{3}{2}\right)^2$
4	96	2
5	150	$\left(\frac{5}{2}\right)^2$

Notice how the surface area increases with the square of the edge length:

$$SA \propto (\text{Edge Length})^2$$

Thus, when increasing the edge length from 2 cm to 4 cm (doubling), the surface area increases by a factor of 4.

Key Takeaways:

- The ratio of surface areas of cubes is proportional to the square of the ratio of their edge lengths.
- The formula for surface area of a cube is straightforward and vital in various scientific and

engineering fields.

- Scaling effects are predictable and can be calculated easily using ratios and proportionality.

Summary and Conclusion

In this comprehensive analysis, we've determined that:

- The surface area of a cube with an edge length of 2 cm is 24 cm².
- The surface area of a larger cube with an edge length of 5 cm is 150 cm².
- The ratio of their surface areas is 4:25, which simplifies from 24:150.
- This ratio reflects the square relationship between edge length and surface area.

Understanding these relationships enhances our ability to estimate material needs, analyze heat transfer, and scale models accurately. Recognizing the proportionality between edge length and surface area is fundamental in geometry and its applications across various disciplines.

Final note: Whether designing small objects or large structures, knowing how surface area scales with size helps in making informed decisions and optimizing designs effectively.

Frequently Asked Questions

What is the surface area of a cube with an edge length of 2 cm?

The surface area is 24 square centimeters, calculated as $6 \times (2)^2 = 6 \times 4 = 24 \text{ cm}^2$.

What is the surface area of a cube with an edge length of 5 cm?

The surface area is 150 square centimeters, calculated as $6 \times (5)^2 = 6 \times 25 = 150 \text{ cm}^2$.

How do you find the ratio of the surface areas of the two cubes?

Divide the surface area of the larger cube by that of the smaller cube: $150 / 24 = 25 / 4$ or 6.25.

What is the simplified ratio of the surface areas of the larger cube to the smaller cube?

The simplified ratio is 25:4.

If the smaller cube's surface area is 24 cm², what is the ratio of surface areas between the larger and smaller cubes?

The ratio is 25:4, as calculated from their surface areas.

How does increasing the edge length from 2 cm to 5 cm affect the surface area ratio?

Since surface area scales with the square of the edge length, the ratio is $(5/2)^2 = 25/4$.

Is the surface area ratio proportional to the cube of the edge lengths?

No, since surface area depends on the square of the edge length, not the cube. The ratio of surface areas is (edge length ratio)².

What is the importance of understanding ratios of surface areas in real-world applications?

It helps in estimating material requirements, scaling models, and understanding how size changes impact surface-related properties like heat transfer or coating.

Additional Resources

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Understanding the geometric relationship between similar shapes is fundamental in mathematics, especially in the study of three-dimensional figures like cubes. When comparing two cubes of different sizes, one of the most insightful metrics is their surface area—an essential property that influences various real-world applications, from manufacturing to architecture. This article delves into the process of calculating the surface areas of two cubes with given edge lengths and determining the ratio between these areas. Through a detailed exploration, we'll uncover the underlying principles and mathematical steps involved, providing clarity for learners and enthusiasts alike.

Fundamentals of Cube Geometry

Before tackling the specific problem, it's vital to understand the basic properties of a cube. A cube is a three-dimensional figure with six equal square faces. Its properties are straightforward but foundational:

- Edge Length (a): The length of any side of the cube.
- Surface Area (SA): The total area covered by all six faces.
- Volume (V): The space contained within the cube.

For a cube with an edge length a :

- Surface Area Formula:

$$SA = 6a^2$$

- Volume Formula:

$$V = a^3$$

Given these formulas, the surface area depends quadratically on the edge length, which means that as the size of the cube changes, the surface area changes proportionally to the square of the edge length.

Calculating the Surface Areas of the Two Cubes

Let's now focus on the specific cubes described:

- Smaller Cube:

$$a_1 = 2 \text{ cm}$$

- Larger Cube:

$$a_2 = 5 \text{ cm}$$

Applying the surface area formula to each:

Surface Area of the Smaller Cube

$$SA_1 = 6 \times (a_1)^2 = 6 \times (2)^2 = 6 \times 4 = 24 \text{ cm}^2$$

Surface Area of the Larger Cube

$$SA_2 = 6 \times (a_2)^2 = 6 \times (5)^2 = 6 \times 25 = 150 \text{ cm}^2$$

This direct calculation provides the surface areas for both cubes, setting the stage for comparing

these values.

Understanding the Ratio of Surface Areas

The ratio of the surface area of the smaller cube to that of the larger cube is expressed as:

$$\text{Ratio} = \frac{SA_1}{SA_2}$$

Substituting the calculated values:

$$\text{Ratio} = \frac{24}{150}$$

Simplifying this fraction:

$$\frac{24}{150} = \frac{24 \div 6}{150 \div 6} = \frac{4}{25}$$

Thus, the ratio of the surface area of the smaller cube to the larger cube is 4:25.

Interpreting the Ratio

This ratio indicates that the smaller cube's surface area is approximately 16% of the larger cube's surface area. To put it into perspective, when the size of a cube increases from 2 cm to 5 cm, its surface area increases by a factor related to the square of the scale factor:

$$\text{Scale factor} = \frac{a_2}{a_1} = \frac{5}{2} = 2.5$$

Since surface area scales with the square of the edge length:

$$\left(\frac{a_2}{a_1}\right)^2 = (2.5)^2 = 6.25$$

This means that the larger cube's surface area is 6.25 times that of the smaller cube, which aligns with our numerical findings:

$$\frac{SA_2}{SA_1} = \frac{150}{24} = 6.25$$

Correspondingly, the ratio of the smaller to the larger is:

$$\frac{1}{6.25} = \frac{4}{25}$$

which confirms our earlier calculation.

Broader Implications and Real-World Applications

Understanding ratios of surface areas is not just a mathematical exercise; it has practical implications across various fields:

Manufacturing and Material Usage

- Surface Coating: When applying paint or protective coatings to objects, knowing the surface area helps estimate material costs.
- Packaging: For packaging design, surface area influences the amount of material used and the overall weight.

Architecture and Design

- Scaling Structures: Architects often scale models or structures; understanding how surface area scales ensures efficient material use.
- Thermal Management: Surface area affects heat exchange; larger surface areas may require different insulation strategies.

Science and Engineering

- Chemical Reactions: In catalysis, surface area impacts the rate of reactions—larger surface areas mean more active sites.
- Biology: Cell surface area influences nutrient absorption and waste elimination.

Educational Significance

Studying how surface area scales with size provides foundational insights into geometric similarity, scaling laws, and proportional reasoning—core concepts that underpin advanced mathematics and physics.

Conclusion: Connecting Mathematics to Practical Understanding

Calculating and comparing the surface areas of two cubes with different edge lengths reveals a fundamental geometric principle: surface area scales with the square of the scale factor. In our specific case, the smaller cube with an edge length of 2 cm has a surface area of 24 cm², while the larger cube with an edge length of 5 cm has a surface area of 150 cm². Their ratio, 4:25, encapsulates how a modest increase in size results in a disproportionately larger surface area.

This exploration underscores the importance of understanding scaling laws in real-world contexts—whether in designing efficient structures, optimizing material use, or comprehending natural phenomena. Recognizing these relationships enhances our ability to analyze and interpret the physical world through mathematical lenses, fostering a deeper appreciation for the elegance and utility of geometry in everyday life.

By mastering these concepts, students and professionals alike can better predict how changes in size influence surface-related properties, paving the way for innovations across multiple disciplines.

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