The Volume Of A Cylinder Having Height One And Half Of The Radius Is 12,936 M3 What Minimum Square Cm

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Understanding the volume of cylinders is fundamental in various fields such as engineering, architecture, manufacturing, and even in everyday problem-solving scenarios. The question about determining the minimum square centimeters based on a given volume, especially when the height and radius are related, is an intriguing mathematical challenge. This article aims to explore this problem comprehensively, providing insights into the formulas involved, step-by-step calculations, and practical applications.

Understanding the Problem Statement

The problem states:

- The volume of a cylinder is 12,936 cubic meters (m^3).
- The height (h) of the cylinder is one and a half times the radius (r).
- The goal is to find the minimum square centimeters (cm^2), which relates to the surface area or perhaps the square of some measurement; however, based on context, it likely refers to the minimum surface area or a related measurement in square centimeters.

Before diving into calculations, it’s essential to interpret and clarify the problem.

Key Concepts and Formulas

To solve this problem, understanding the formulas for the volume and surface area of a cylinder is vital.

Volume of a Cylinder

The volume (V) of a cylinder is given by:

$$ V = \pi r^2 h $$

where:
- r = radius of the cylinder
- h = height of the cylinder

Relationship Between Height and Radius

Given:
$$ h = 1.5r $$

This relationship simplifies calculations by expressing height in terms of radius, reducing the number of variables.

Surface Area of a Cylinder

The surface area (A) includes the lateral surface area and the area of the two circular bases:
$$ A = 2\pi r h + 2 \pi r^2 $$

Depending on the problem's context, the "minimum square cm" could refer to the minimum surface area, or possibly the square of the radius or height converted to centimeters.

Converting Units and Setting Up the Equation

Since the volume is given in cubic meters and the final answer in square centimeters, unit conversion is essential.

Unit Conversion

- 1 meter (m) = 100 centimeters (cm)
- Therefore:
- 1 m^3 = $(100\,cm)^3 = 1,000,000\,cm^3$

Given:
$$ V = 12,936\,m^3 $$
Convert to cm^3:
$$ V = 12,936 \times 1,000,000 = 12,936,000,000\,cm^3 $$

Deriving the Equation for Radius and Height

Using the volume formula:
$$ V = \pi r^2 h $$

Substitute $h = 1.5 r$:
$$ V = \pi r^2 (1.5 r) = 1.5 \pi r^3 $$

Rearranged to solve for r:
$$ r^3 = \frac{V}{1.5 \pi} $$

Plug in the known volume:
$$ r^3 = \frac{12,936,000,000}{1.5 \pi} $$

Calculate the denominator:
$$ 1.5 \pi \approx 1.5 \times 3.1416 = 4.7124 $$

Thus:
$$ r^3 = \frac{12,936,000,000}{4.7124} $$

Calculating the Radius

Compute:
$$ r^3 \approx \frac{12,936,000,000}{4.7124} $$
$$ r^3 \approx 2,746,644,874.3 $$

Now, find r by taking the cube root:
$$ r \approx \sqrt[3]{2,746,644,874.3} $$

Using a calculator:
$$ r \approx 1,404.9\,cm $$

Since the radius in centimeters is approximately 1,404.9 cm, the height h is:
$$ h = 1.5 \times r \approx 1.5 \times 1,404.9 \approx 2,107.35\,cm $$

Calculating the Surface Area or Relevant Square Measurement

Depending on the interpretation, the problem asks for the minimum square centimeters, which likely refers to the surface area or perhaps the square of the radius or height in cm.

If the goal is to find the square of the radius:
$$ r^2 = (1,404.9)^2 \approx 1,974,721\,cm^2 $$

If the goal is to find the surface area:
Using:
$$ A = 2\pi r h + 2 \pi r^2 $$
Plugging in the values:
$$ A = 2 \times 3.1416 \times 1,404.9 \times 2,107.35 + 2 \times 3.1416 \times (1,404.9)^2 $$

Calculate each part:

Lateral surface area:
$$ 2 \times 3.1416 \times 1,404.9 \times 2,107.35 $$
$$ \approx 6.2832 \times 1,404.9 \times 2,107.35 $$
$$ \approx 6.2832 \times 2,958,210.6 $$
$$ \approx 18,582,458.4\,cm^2 $$

Area of the bases:
$$ 2 \times 3.1416 \times (1,404.9)^2 $$
$$ \approx 6.2832 \times 1,974,721 $$
$$ \approx 12,415,887.3\,cm^2 $$

Total surface area:
$$ A \approx 18,582,458.4 + 12,415,887.3 $$
$$ \approx 30,998,345.7\,cm^2 $$

Summary of Calculations and Results

Measurement	Value in cm	Interpretation
Radius r	1,404.9 cm	Derived from volume
Height h	2,107.35 cm	$1.5 \times r$
Radius squared r^2	1,974,721 cm^2	Square of radius
Surface area A	approximately 30,998,346 cm^2	Total surface area

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Practical Applications and Significance

Understanding how to compute the volume and surface area of cylinders with given relationships has multiple real-world applications:

- Engineering: Design of tanks, silos, and pipes where volume and surface

area influence material selection and cost.
- Manufacturing: Calculating the amount of material needed for cylindrical objects.
- Environmental Science: Estimating capacities and surface interactions of cylindrical reservoirs.
- Architecture: Planning cylindrical structures and their surface finishing requirements.

Conclusion

The problem of finding the minimum square centimeters based on a cylinder's volume, with a height that is one and a half times its radius, involves several steps: converting units, deriving the radius from the volume, and then calculating the desired measurement—be it the radius squared, surface area, or other relevant metrics.

By following a systematic approach, we determined that for a cylinder with a volume of 12,936 m^3 and height related to the radius, the radius is approximately 1,404.9 cm, and the corresponding surface area is roughly 30,998,346 cm^2. The specific "minimum square cm" could refer to the squared radius or the surface area, depending on the interpretation, but the calculations provide a comprehensive understanding of the cylinder's dimensions.

This exercise underscores the importance of unit conversion, algebraic manipulation, and understanding geometric formulas in solving complex real-world problems. Whether for academic pursuits or practical applications, mastering these calculations equips individuals with valuable tools for diverse technical challenges.

References:

- Geometry and Measurement Textbooks
- Engineering Mathematics Resources
- Online Calculators for Cube Roots and Area Calculations

Keywords: Cylinder volume, radius, height, surface area, unit conversion, mathematical problem-solving, engineering calculations, geometric formulas

Frequently Asked Questions

What is the volume of a cylinder with height equal to half of its radius if the volume is 12,936 m^3?

The volume given is 12,936 m^3 for a cylinder with height $H = R/2$. Using the volume formula $V = \pi R^2 H$ and substituting $H = R/2$, we get $V = (\pi R^3)/2$. Solving for R: $R = (2V / \pi)^{1/3}$. Plugging in $V = 12{,}936\ m^3$, $R \approx 12.936$ meters.

How do you convert the volume from cubic meters to cubic centimeters for this problem?

Since 1 cubic meter equals 1,000,000 cubic centimeters, multiply the volume in cubic meters by 1,000,000. For 12,936 m^3, the volume in cm^3 is $12{,}936 \times 1{,}000{,}000 = 12{,}936{,}000{,}000\ cm^3$.

What is the minimum square centimeter area of the base of the cylinder given the volume?

The minimum base area in cm^2 can be found using the radius R in cm. First, convert R to cm ($R = 12.936$ m $= 1{,}293.6$ cm). The base area $A = \pi R^2 \approx 3.1416 \times (1293.6)^2 \approx 5{,}260{,}188\ cm^2$.

Why is the minimum square centimeters of the base important in this context?

Calculating the minimum base area helps determine the smallest possible surface area or footprint needed for the cylinder, which can be relevant for material optimization or spatial planning.

How does the relationship between height and radius affect the volume calculation?

Since height $H = R/2$, the volume formula becomes $V = \pi R^2 (R/2) = (\pi R^3)/2$, showing that volume depends cubically on the radius, which simplifies solving for R when the volume is known.

What steps are involved in finding the radius from the given volume?

First, express volume as $V = (\pi R^3)/2$, then solve for R: $R = (2V / \pi)^{1/3}$. Plug in the known volume to compute R, ensuring units are consistent.

What is the significance of converting measurements to centimeters in this problem?

Converting to centimeters allows for precise calculation of the base area in more practical units, especially when dealing with smaller measurements or when designing real-world structures requiring detailed dimensions.

Additional Resources

The Volume Of A Cylinder Having Height One And Half Of The Radius Is 12,936 M^3: What Is The Minimum Square Cm?

In the realm of geometry and mathematical problem-solving, understanding the volume of cylinders is fundamental, especially when dealing with specific conditions such as a height equal to one and half of the radius. When faced with a problem stating, "The volume of a cylinder having height one and half of the radius is 12,936 cubic meters (M^3)," it becomes essential to analyze the given parameters carefully and determine the minimum possible surface area in square centimeters (cm^2). This guide aims to unravel this complex problem step-by-step, providing clarity, detailed calculations, and insights into how such geometric relationships function.

Understanding the Problem

Before diving into calculations, it’s important to clarify the problem statement:

- Given:
- The volume of the cylinder is 12,936 m^3.
- The height (h) of the cylinder is 1 unit (assumed meters unless otherwise specified).
- The radius (r) of the cylinder is half of the height, i.e., r = h/2.

- Find:
- The minimum surface area of this cylinder expressed in square centimeters (cm^2).

Step 1: Interpreting the Parameters

The Relationship Between Height and Radius

The problem states:
> "Having height one and half of the radius is 12,936 m^3."

This phrase can be interpreted in two ways:

1. The height (h) is 1 meter, and the radius (r) is half of the height, i.e., r = h/2 = 0.5 meters.

2. The volume of the cylinder is 12,936 m^3, and the height is one, with the

radius being half of the height.

Given the terminology, the most logical interpretation is:

- The height (h) is 1 meter.
- The radius (r) is h/2 = 0.5 meters.
- The volume of the cylinder, calculated with these dimensions, should be 12,936 m^3.

But this leads to a contradiction because:

$$ V = \pi r^2 h $$

Substituting:

$$ V = \pi (0.5)^2 \times 1 = \pi \times 0.25 = 0.7854 \text{ m}^3 $$

which is nowhere near 12,936 m^3.

Alternative Interpretation

Alternatively, perhaps the problem is:

- The volume of the cylinder is 12,936 m^3.
- The height (h) is one (i.e., 1 meter).
- The radius (r) is half of the height, i.e., r = 0.5 meters.

Calculating the volume with these:

$$ V = \pi r^2 h = \pi \times (0.5)^2 \times 1 = \pi \times 0.25 = 0.7854 \text{ m}^3 $$

Again, this is too small compared to 12,936 m^3.

Final Clarification

Given the phrase: "The volume of a cylinder having height one and half of the radius is 12,936 m^3," it seems more plausible that:

- The height (h) is 1 (unit unspecified, but likely meters).
- The radius (r) is half of the height, so:

$$ r = \frac{h}{2} = \frac{1}{2} = 0.5 \text{ meters} $$

- The volume is 12,936 m^3.

But as shown, with these dimensions, the volume is approximately 0.7854 m^3, which is inconsistent with 12,936 m^3.

Therefore, the most logical interpretation is:

> The volume of a cylinder is 12,936 m^3.
> The height (h) of the cylinder is 1.
> The radius (r) is half of the height, i.e., r = 0.5 meters.

This leads to a contradiction unless the height is not 1 meter but 1 unit, and half of the radius is 12,936 m^3, which doesn't make sense dimensionally.

Corrected Interpretation

Given the complexity, the most reasonable assumption is:

- The volume (V) of the cylinder is 12,936 m^3.
- The height (h) is 1.
- The radius (r) is half of the height, so:

$$ r = \frac{h}{2} $$

- We need to verify if these match the volume.

Calculating the volume:

$$ V = \pi r^2 h = \pi \left(\frac{h}{2}\right)^2 h = \pi \frac{h^3}{4} $$

Set equal to 12,936:

$$ \pi \frac{h^3}{4} = 12,936 $$

Solve for h:

$$ h^3 = \frac{4 \times 12,936}{\pi} $$

$$ h^3 = \frac{51,744}{\pi} $$

Calculate:

$$ h^3 \approx \frac{51,744}{3.1416} \approx 16,487.3 $$

Then:

$$ h \approx \sqrt[3]{16,487.3} \approx 25.4 \text{ meters} $$

Now, find r:

$$ r = \frac{h}{2} \approx 12.7 \text{ meters} $$

Summary:

- Height (h): approximately 25.4 meters.
- Radius (r): approximately 12.7 meters.

Step 2: Calculating the Surface Area

The surface area A of a cylinder (including top and bottom) is:

$$ A = 2\pi r^2 + 2\pi r h $$

- The first term is the area of the two circular bases.
- The second term is the lateral surface area.

Convert meters to centimeters:

Since the final answer asks for square centimeters (cm^2):

$$ 1 \text{ meter} = 100 \text{ centimeters} $$

Therefore:

- $ r \approx 12.7 \text{ meters} = 1270 \text{ cm} $
- $ h \approx 25.4 \text{ meters} = 2540 \text{ cm} $

Calculate each component:

1. Area of the two bases:

$$ 2 \pi r^2 = 2 \times 3.1416 \times (1270)^2 $$

$$ = 6.2832 \times 1,612,900 $$

$$ \approx 6.2832 \times 1,612,900 \approx 10,139,921 \text{ cm}^2 $$

2. Lateral surface area:

$$ 2 \pi r h = 2 \times 3.1416 \times 1270 \times 2540 $$

$$ = 6.2832 \times 1270 \times 2540 $$

Calculate:

$$ 1270 \times 2540 = 3,226,800 $$

Then:

$$ 6.2832 \times 3,226,800 \approx 20,290,000 \text{ cm}^2 $$

Total surface area:

$$ A \approx 10,139,921 + 20,290,000 \approx 30,429,921 \text{ cm}^2 $$

Step 3: Final Answer – The Minimum Surface Area in Square Centimeters

Given the calculations, the minimum surface area of the cylinder, based on the parameters and the derived dimensions, is approximately:

30,429,921 cm^2

Summary and Key Takeaways

- The problem involves understanding the relationship between volume, height, and radius of a cylinder.
- Interpreting the phrase "height one and half of the radius" led us to assume the height is approximately 25.4 meters and the radius about 12.7 meters.
- Converting these dimensions into centimeters allows computation of surface area in square centimeters.
- The minimum surface area for the given volume and constraints is approximately 30,429,921 cm^2.

Additional Insights

Why is this important?

Understanding how to manipulate the relationships between dimensions in a cylinder – especially with constraints like volume and proportional dimensions – is crucial in engineering, manufacturing, and design tasks where material minimization or surface area optimization is needed.

Practical Applications

- Container design: Minimizing material use for a given volume.
- Cooling systems: Maximizing surface area for heat dissipation.
- Structural engineering: Balancing strength and material efficiency.

Final Tips for Problem Solving

- Always clarify and interpret the problem statement carefully.
- Convert all measurements to consistent units before calculations.
- Use algebraic substitution for relationships between variables.
- Cross-verify your dimensions with the given volume to ensure consistency.

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