Volume with Fractional Edge Lengths

Volume with Fractional Edge Lengths: Apply, Compare, and Design

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QUICK REVIEW

A cube with edge $\frac{1}{2}$ cm occupies $\frac{1}{8}$ cm^3. Two half-centimeter edges fit along 1 cm. For a rectangular prism, count cubes along each dimension, then multiply the counts. For a missing height, find the volume of one known layer and count equal layers using a common denominator.

Worked example

A rectangular prism made of half-centimeter cubes is $1\frac{1}{2}$ cm long, 1 cm wide, and $1\frac{1}{2}$ cm tall. Count the cubes and find their volume.

1. Each $1\frac{1}{2}$ cm edge holds 3 half-centimeter edges. The 1 cm edge holds 2.

2. There are $3 \times 2 \times 3 = 18$ cubes. Each occupies $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$ cm^3.

3. All 18 cubes occupy $18 \times \frac{1}{8} = \frac{18}{8} = \frac{9}{4}$ cm^3.

Answer: 18 cubes; $\frac{9}{4}$ cm^3.

Practice Problems

Show your thinking.

1. A storage mold has a rectangular prism interior 3 cm long, $1\frac{1}{2}$ cm wide, and 2 cm high. It already contains $\frac{13}{4}$ cm^3 of clay. How much more can it hold?

2. Two tray plans have rectangular prism interiors. Plan A measures 4 by 1 by $1\frac{1}{2}$ cm inside; plan B measures 2 by 2 by 2 cm inside. Height is listed last. Which holds at least 6 cm^3 and has an inside height of at most $1\frac{1}{2}$ cm?

3. A 2 cm-high rectangular prism has a 2 cm by $3\frac{1}{2}$ cm base. A $\frac{1}{2}$ cm-thick layer is shaved from the entire top. How much volume is removed, and how much is left?

4. Water is $2\frac{1}{2}$ cm deep in a rectangular prism tank with an inside base area of 3 cm^2. It is poured without loss into an empty, taller rectangular prism tank with an inside base area of 6 cm^2. Find the new water depth.

5. You have 80 cubes with $\frac{1}{2}$ cm edges. Each gift set uses two solid rectangular prisms, each 2 by 1 by $1\frac{1}{2}$ cm. How many full sets can you build, and what volume of cubes is left?

6. Build a rectangular prism with all 24 cubes of edge $\frac{1}{2}$ cm in two equal complete layers. Neither base edge may exceed $2\frac{1}{2}$ cm. Find the base edge lengths.

Answer Key

1. $\frac{23}{4}$ cm^3.
2. Only A: 6 cm^3 and $1\frac{1}{2}$ cm high.
3. $\frac{7}{2}$ cm^3 removed; $\frac{21}{2}$ cm^3 left.
4. $1\frac{1}{4}$ cm.
5. 1 full set; 4 cm^3 of cubes left.
6. $1\frac{1}{2}$ cm and 2 cm, in either order.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The capacity is $3 \times \frac{3}{2} \times 2 = 9$ cm^3.
2. Convert to fourths and subtract: $\frac{36}{4} - \frac{13}{4} = \frac{23}{4}$ cm^3.

Problem 2

1. A holds $4 \times 1 \times \frac{3}{2} = 6$ cm^3 and meets the height limit exactly.
2. B holds $2 \times 2 \times 2 = 8$ cm^3, but $2 > \frac{3}{2}$, so it is too tall.

Problem 3

1. The base is $2 \times \frac{7}{2} = 7$ cm^2. The shaving occupies $7 \times \frac{1}{2} = \frac{7}{2}$ cm^3.
2. The remaining height is $2 - \frac{1}{2} = \frac{3}{2}$ cm. The remaining volume is $7 \times \frac{3}{2} = \frac{21}{2}$ cm^3.

Problem 4

1. The new base area is $2 \times 3 = 6$ cm^2. At the old height it would need twice as much water.
2. For the same volume, halve the height: $\frac{1}{2} \times \frac{5}{2} = \frac{5}{4}$ cm.
3. Check the water volume: $6 \times \frac{5}{4} = \frac{15}{2}$ cm^3, the same as $3 \times \frac{5}{2}$.

Problem 5

1. One block takes $4 \times 2 \times 3 = 24$ half-centimeter cubes. A set takes $2 \times 24 = 48$ cubes.
2. Two sets would take $2 \times 48 = 96$ cubes, so only one set fits the supply.
3. There are $80 - 48 = 32$ cubes left, occupying $32 \times \frac{1}{8} = 4$ cm^3.

Problem 6

1. Each layer uses $24 \div 2 = 12$ cubes. The edge limit is 5 half-centimeter cube edges.
2. The factor pairs of 12 are 1×12, 2×6, and 3×4. Only the last pair has both counts at most 5.
3. The base edges measure $3 \times \frac{1}{2} = \frac{3}{2}$ cm and $4 \times \frac{1}{2} = 2$ cm.

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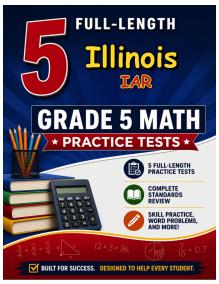

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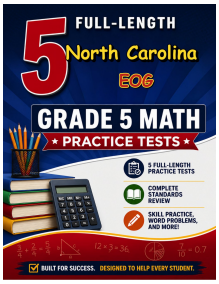

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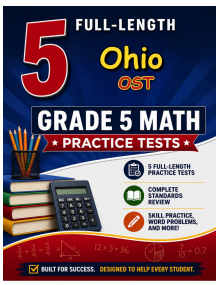

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