Volume of Cylinders, Cones, and Spheres

Investigate mistakes and missing measures

Name _____ **Date** _____ **Score** _____ / 10

QUICK REVIEW

Use $V = \pi r^2 h$ for a cylinder, $V = \frac{1}{3}\pi r^2 h$ for a cone, and $V = \frac{4}{3}\pi r^3$ for a sphere. Here r is radius, not diameter, and h is perpendicular height, not slant height. Equal-base, equal-height cones have one third the cylinder volume. Keep π exact until the final approximation; volume uses cubic units.

Worked example

Find the volume of a cone with radius 3 and perpendicular height 7. Give the exact volume in terms of π and an approximation to the nearest tenth.

1. The radius is $r = 3$ units; it is already a radius, so do not halve it.
2. Substitute the dimensions into the cone formula: $V = \frac{1}{3}\pi r^2 h = \frac{1}{3}\pi(3)^2(7) = 21\pi$ cubic units.
3. The exact volume is 21π cubic units. Using calculator π gives 66.0 cubic units; round only this final result.
Answer: $21\pi \approx 66.0$ cubic units

Practice Problems

Show your thinking.

1. A cylinder has volume 80π and radius 4. Recover its height.

2. A cone has volume 45π and radius 3. Recover its perpendicular height.

3. A sphere has volume 288π. Find its radius.

4. A student uses $r = 8$ for a cylinder with diameter 8 and height 5. Correct the exact volume.

5. A cone with radius 2 and height 9 is assigned volume 36π. Correct the omitted factor.

6. A cylinder volume is 72π and height 8. Recover its positive radius.

7. A sphere radius doubles from 2 to 4. A student predicts double volume. Find the actual volume factor.

8. A cylinder and cone have equal radius 3 and equal volume. The cylinder height is 4. Find the cone height.

9. Which cylinder is larger: radius 2, height 10; or radius 3, height 4? Give the exact difference.

10. A cone has radius 3, perpendicular height 4, and slant height 5. A student uses 5 in the volume formula. Correct it.

Answer Key

1. 5 units
2. 15 units
3. 6 units
4. 80π cubic units
5. 12π cubic units
6. 3 units
7. 8
8. 12 units
9. First cylinder, by 4π cubic units.
10. 12π cubic units

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Substitute into $V = \pi r^2 h$: $80\pi = \pi(4)^2 h = 16\pi h$.
2. Divide by 16π: $h = 80/16 = 5$ units.
3. Check $\pi(4)^2(5) = 80\pi$. The inverse calculation divides by base area, not circumference.

Problem 2

1. The cone equation is $45\pi = \frac{1}{3}\pi(3)^2 h = 3\pi h$.
2. Divide by 3π: $h = 15$ units.
3. Checking $\frac{1}{3}\pi(9)(15) = 45\pi$ verifies the height. Omitting the one-third factor would incorrectly give 5.

Problem 3

1. Substitute into the sphere formula: $288\pi = \frac{4}{3}\pi r^3$.
2. Cancel π and multiply by $3/4$: $r^3 = 288(3/4) = 216$, so $r = 6$.
3. The check $\frac{4}{3}\pi(6)^3 = 288\pi$ confirms the radius; its diameter would be 12, not 6.

Problem 4

1. The radius is $8/2 = 4$, so the correct equation is $V = \pi(4)^2(5)$.
2. The volume is $16(5)\pi = 80\pi$ cubic units, not $\pi(8)^2(5) = 320\pi$.
3. The incorrect volume is $320/80 = 4$ times too large, because the radius was doubled before being squared.

Problem 5

1. The product $\pi(2)^2(9) = 36\pi$ is the matching cylinder volume.
2. The cone needs the factor $1/3$: $V = \frac{1}{3}(36\pi) = 12\pi$.
3. The correction reduces the answer by a factor of 3, not by subtracting 3 cubic units.

Problem 6

1. The equation $72\pi = \pi r^2(8)$ gives $r^2 = 72/8 = 9$.
2. Take the positive root: $r = \sqrt{9} = 3$ units.
3. The check $\pi(3)^2(8) = 72\pi$ works. The value 9 is the squared radius, not the requested length.

Problem 7

1. The original volume is $\frac{4}{3}\pi(2)^3 = \frac{32}{3}\pi$.
2. The new volume is $\frac{4}{3}\pi(4)^3 = \frac{256}{3}\pi$. The ratio is $256/32 = 8$.
3. Volume scales as r^3, so doubling the radius multiplies volume by $2^3 = 8$, not by 2.

Problem 8

1. The cylinder volume is $\pi(3)^2(4) = 36\pi$.
2. For the cone, $\frac{1}{3}\pi(3)^2 h = 36\pi$, so $3h = 36$ and $h = 12$.
3. The cone must be three times as tall: $12/4 = 3$. Equal radius alone does not make the two formulas equal.

Problem 9

1. The first volume is $\pi(2)^2(10) = 40\pi$. The second is $\pi(3)^2(4) = 36\pi$.
2. The difference is $40\pi - 36\pi = 4\pi$ cubic units.
3. Since $40\pi > 36\pi$, the first cylinder wins. Comparing only radii or only heights would not establish the volume ordering.

Problem 10

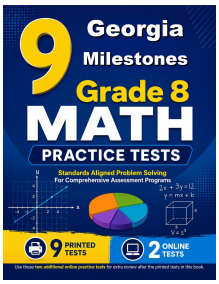
1. The volume uses perpendicular height 4: $V = \frac{1}{3}\pi(3)^2(4)$.
2. This gives $V = \frac{1}{3}(9)(4)\pi = 12\pi$, rather than $\frac{1}{3}(9)(5)\pi = 15\pi$.
3. The slant height measures along the surface, not perpendicular to the base, so the student overestimated by 3π cubic units.

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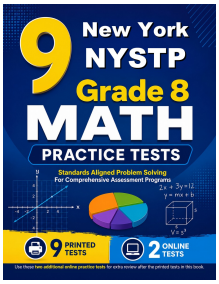
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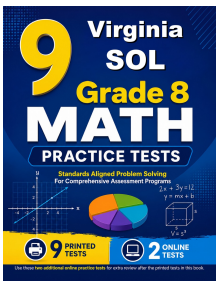
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