

Volume of Pyramids

Name: _____

Date: _____

Score: _____ / 17

Here is a cool fact: a pyramid holds exactly *one third* the volume of a prism with the same base and height—and that is why the formula is $V_{\text{pyramid}} = \frac{1}{3}Bh$! The height in this formula is the **vertical** height, not the slant height along a face, so watch out for that common mixup. Once the one-third relationship makes sense to you, the formula stops feeling like something to memorize and starts feeling like something you *understand*.



One pyramid holds one third of the matching prism.

Key Concepts & Quick Review

Any pyramid: $V = \frac{1}{3} \times B \times h$ (B = base area, h = **vertical** height, not slant height ℓ).

Square pyramid: $V = \frac{1}{3}b^2h$. **Triangular pyramid:** $V = \frac{1}{3} \cdot \frac{1}{2}b_{\Delta}h_{\Delta} \cdot H$.

Three pyramids of the same base and height = one prism of the same base and height.

Examples

① Find the volume of a square pyramid: base 9 cm , height 12 cm .

Think It Through: Use the pyramid volume formula $V = \frac{1}{3}Bh$. For a square base of side 9 cm , the base area is $B = 9^2 = 81\text{ cm}^2$. Then multiply by the vertical height 12 and take one third: $V = \frac{1}{3}(81)(12) = 324\text{ cm}^3$. The $\frac{1}{3}$ factor is what makes a pyramid smaller than a prism with the same base and height.

Answer: 324 cm^3

② A rectangular-base pyramid has base $10\text{ m} \times 6\text{ m}$ and height 9 m . Find its volume. How does it compare to the prism with the same base and height?

Think It Through: Start with the base area: $B = 10 \times 6 = 60\text{ m}^2$. Then use $V_{\text{pyr}} = \frac{1}{3}Bh = \frac{1}{3}(60)(9) = 180\text{ m}^3$. A prism with the same base and height would have volume $Bh = 60 \times 9 = 540\text{ m}^3$. That is exactly three times the pyramid volume, which matches the standard prism-pyramid relationship.

Answer: $V = 180\text{ m}^3$; prism is $3\times$ larger



 **Practice Problems**

Find the volume of each pyramid.

1. A square pyramid has base side length 6 units and vertical height 4 units. Find its volume. _____
2. A square pyramid has base side length 9 units and vertical height 10 units. Find its volume. _____
3. A square pyramid has base side length 5 units and vertical height 12 units. Find its volume. _____
4. A square pyramid has base side length 8 units and vertical height 9 units. Find its volume. _____
5. A square pyramid has base side length 3 units and vertical height 7 units. Find its volume. _____
6. A pyramid has a rectangular base measuring 8 by 6 units and vertical height 5 units. Find its volume. _____
7. A pyramid has a rectangular base measuring 10 by 4 units and vertical height 9 units. Find its volume. _____
8. A pyramid has a triangular base with base 6 units and height 4 units. The pyramid's vertical height is 10 units. Find its volume. _____
9. A square pyramid has base side length 12 units and vertical height 8 units. Find its volume. _____
10. A square pyramid has base side length 2 units and vertical height 15 units. Find its volume. _____
11. A square pyramid has base side length x units and vertical height 6 units. If $x = 5$, find the volume. _____



12. A square pyramid has volume 192 cubic units and base side length 8 units. Find its vertical height. _____



13. A square pyramid has volume 75 cubic units and vertical height 9 units. Find its base side length. _____



14. A pyramid has base area 36 square units and vertical height 15 units. Find its volume. _____



15. A square pyramid has base side length 10 units and vertical height 3 units. Find its volume. _____



Study Tips

- ✎ Always use the **vertical height** h (from base to apex, perpendicular to base) — not the slant height l .
- ✎ The $\frac{1}{3}$ factor is not optional — it's the essential difference between a pyramid and a prism. Forgetting it triples your answer.
- ✎ **Sanity check:** pyramid volume must always be *less than* the prism with the same base and height. If it's not, recheck.

Word Problems

16. An ancient Egyptian stone pyramid has a square base of 200 m and a vertical height of 120 m . Find its volume in cubic meters. If the stone has a density of $2,500\text{ kg/m}^3$, estimate the mass of the pyramid in kg. Express it in scientific notation. _____
17. A sand hopper on a construction site drops sand into a pile shaped like a square pyramid. The base is $3\text{ m} \times 3\text{ m}$ and the pile grows at a rate of 0.5 m in height per minute. Find the volume after 4 min and after 10 min . At what height will the volume reach 18 m^3 ? _____



Answer Keys

- | | |
|---|---|
| <p>1) 48
2) 270
3) 100
4) 192
5) 21
6) 80
7) 120
8) 40
9) 384</p> | <p>10) 20
11) 50
12) 9
13) 5
14) 180
15) 100
16) $1,600,000 m^3$; mass $4 \times 10^9 kg$
17) After 4 min: $6 m^3$; after 10 min: $15 m^3$; for $18 m^3$: $h = 6 m$</p> |
|---|---|

Step-by-Step Explanations

Strategy: For Circumference of Circles, decide whether the problem gives radius or diameter before choosing the circumference formula. Circle problems become predictable once radius and diameter are separated.

Practice 1: Find the circumference of a circle with radius $5 cm$. **Answer:** $31.4 cm$

For the first sample, use diameter with C equals pi d or radius with C equals two pi r .

Practice 15: Find the circumference of a circle with diameter $4.2 cm$. **Answer:** $13.19 cm$

Late in the set, use diameter with C equals pi d or radius with C equals two pi r .

Word-problem notes:

16. Answer: $C = 2\pi(40) \approx 251.3 m$; laps = $5,000/251.3 \approx 19.9$, so 20 laps; time = $5/8 \times 60 = 37.5 min$.

Use the radius to find the track circumference: $C = 2\pi r = 2\pi(40) \approx 251.3 m$. The athlete wants to run $5 km$, which is $5,000 m$, so divide by one lap length: $5,000 \div 251.3 \approx 19.9$. Since she needs complete laps to reach at least $5 km$, she must run 20 laps. For the running time, use time = $\frac{\text{distance}}{\text{speed}} = \frac{5}{8}$ hour, which is $37.5 min$.

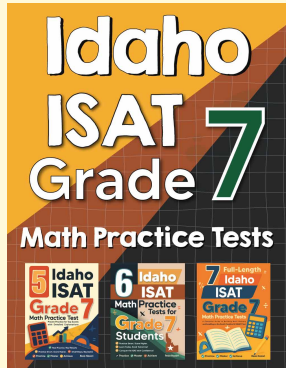
17. Answer: $C = \pi(36) \approx 113.1 cm$; border area $\approx 113.1 \times 2 \approx 226.2 cm^2$.

The crust border goes all the way around the pizza, so its length is the pizza's circumference. Since the diameter is $36 cm$, use $C = \pi d = \pi(36) \approx 113.1 cm$. The border is about $2 cm$ wide, so its area can be estimated by treating it like a long thin strip: length times width, or $113.1 \times 2 \approx 226.2 cm^2$.



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