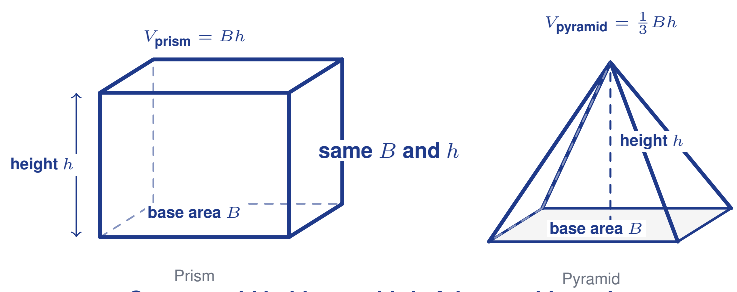
Volume of Pyramids

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:** $V = \frac{1}{3} \cdot \frac{1}{2}b_{\triangle}h_{\triangle} \cdot H$.
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 $B = 9^2 = 81\ cm^2$. Then multiply by the vertical height 12 and take one third: $V = \frac{1}{3}(81)(12) = 324\ cm^3$. The $\frac{1}{3}$ factor is what makes a pyramid smaller than a prism with the same base and height.

Answer: $324\ cm^3$

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

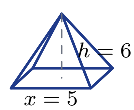
Think It Through: Start with the base area: $B = 10 \times 6 = 60\ m^2$. Then use $V_{\text{pyr}} = \frac{1}{3}Bh = \frac{1}{3}(60)(9) = 180\ m^3$. A prism with the same base and height would have volume $Bh = 60 \times 9 = 540\ m^3$. That is exactly three times the pyramid volume, which matches the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

Answer: $V = 180\ m^3$; *prism is* $3\times$ *larger*

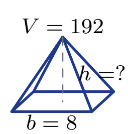
Practice Problems

Find the volume of each pyramid.

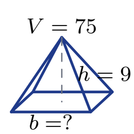
1. A square pyramid has base side length 6 units and vertical height 4 units. Find its volume. ______
2. A square pyramid has base side length 9 units and vertical height 10 units. Find its volume. ______
3. A square pyramid has base side length 5 units and vertical height 12 units. Find its volume. ______
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. ______



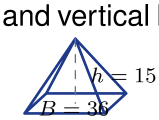
12. A square pyramid has volume 192 cubic units and base side length 8 units. Find its vertical height. ______



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 $2{,}500\,kg/m^3$, 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 $3\,m \times 3\,m$ 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

1) 48
2) 270
3) 100
4) 192
5) 21
6) 80
7) 120
8) 40
9) 384
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 $18\ m^3$: $h = 6\ m$

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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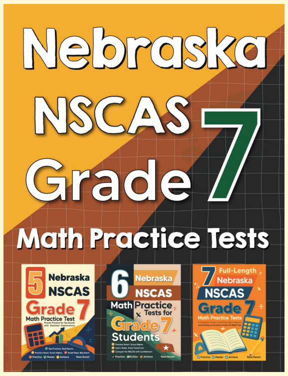

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