# Square Roots and Cube Roots

Roots and Inverse Powers

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

### QUICK REVIEW

The principal square root $\sqrt{a}$ is the nonnegative number whose square is $a$, for $a \geq 0$. The real cube root $\sqrt[3]{b}$ is the number whose cube is $b$; it may be negative. For example, $\sqrt{36} = 6$ but $\sqrt[3]{-27} = -3$. Solving $x^2 = 36$ gives both signs, $x = \pm 6$, unlike evaluating the principal root alone.

**Worked example**

Evaluate $\sqrt{\frac{49}{100}}$ exactly.

**1.** Test the candidate $\frac{7}{10}$ by multiplying $2$ identical factors: $(\frac{7}{10}) \cdot (\frac{7}{10}) = \frac{49}{100}$. This reproduces the given radicand exactly.
**2.** The square-root symbol selects the nonnegative candidate. Since $\frac{7}{10} \geq 0$ and $(\frac{7}{10})^2 = \frac{49}{100}$, $\sqrt{\frac{49}{100}} = \frac{7}{10}$; no negative root is included.
**Answer:** $\frac{7}{10}$

## Practice Problems

Show your thinking.

**1.** Evaluate $\sqrt{169}$ exactly.

**2.** Evaluate $\sqrt[3]{343}$ exactly.

**3.** Evaluate $\sqrt[3]{-216}$ exactly.

**4.** Evaluate $\sqrt{0.81}$ exactly.

**5.** Evaluate $\sqrt[3]{0.064}$ exactly.

**6.** Evaluate $\sqrt{\frac{25}{36}}$ exactly.

**7.** Evaluate $\sqrt[3]{-\frac{8}{27}}$ exactly.

**8.** Solve $x^2 = 64$ over the real numbers.

**9.** Solve $y^3 = -125$ over the real numbers.

**10.** Evaluate $\sqrt{144} - \sqrt[3]{27}$.

# Answer Key

1. $13$
2. $7$
3. $-6$
4. $0.9$
5. $0.4$
6. $\frac{5}{6}$
7. $-\frac{2}{3}$
8. $x = -8$ or $x = 8$.
9. $y = -5$.
10. $9$.

## Step-by-Step Solutions

Follow each calculation, then check your own work.

### Problem 1

**1.** Test the candidate $13$ by multiplying $2$ identical factors: $(13) \cdot (13) = 169$. This reproduces the given radicand exactly.

**2.** The square-root symbol selects the nonnegative candidate. Since $13 \geq 0$ and $(13)^2 = 169$, $\sqrt{169} = 13$; no negative root is included.

### Problem 2

**1.** Test the candidate $7$ by multiplying $3$ identical factors: $(7) \cdot (7) \cdot (7) = 343$. This reproduces the given radicand exactly.

**2.** Cubing preserves the sign, so the real cube root of $343$ is $7$. Thus $\sqrt[3]{343} = 7$, the unique real number with the verified cube.

### Problem 3

**1.** Test the candidate $-6$ by multiplying $3$ identical factors: $(-6) \cdot (-6) \cdot (-6) = -216$. This reproduces the given radicand exactly.

**2.** Cubing preserves the sign, so the real cube root of $-216$ is $-6$. Thus $\sqrt[3]{-216} = -6$, the unique real number with the verified cube.

### Problem 4

**1.** Test the candidate $0.9$ by multiplying $2$ identical factors: $(0.9) \cdot (0.9) = 0.81$. This reproduces the given radicand exactly.

**2.** The square-root symbol selects the nonnegative candidate. Since $0.9 \geq 0$ and $(0.9)^2 = 0.81$, $\sqrt{0.81} = 0.9$; no negative root is included.

### Problem 5

**1.** Test the candidate $0.4$ by multiplying $3$ identical factors: $(0.4) \cdot (0.4) \cdot (0.4) = 0.064$. This reproduces the given radicand exactly.

**2.** Cubing preserves the sign, so the real cube root of $0.064$ is $0.4$. Thus $\sqrt[3]{0.064} = 0.4$, the unique real number with the verified cube.

### Problem 6

**1.** Test the candidate $\frac{5}{6}$ by multiplying $2$ identical factors: $(\frac{5}{6}) \cdot (\frac{5}{6}) = \frac{25}{36}$. This reproduces the given radicand exactly.

**2.** The square-root symbol selects the nonnegative candidate. Since $\frac{5}{6} \geq 0$ and $(\frac{5}{6})^2 = \frac{25}{36}$, $\sqrt{\frac{25}{36}} = \frac{5}{6}$; no negative root is included.

### Problem 7

**1.** Test the candidate $-\frac{2}{3}$ by multiplying $3$ identical factors: $(-\frac{2}{3}) \cdot (-\frac{2}{3}) \cdot (-\frac{2}{3}) = -\frac{8}{27}$. This reproduces the given radicand exactly.

**2.** Cubing preserves the sign, so the real cube root of $-\frac{8}{27}$ is $-\frac{2}{3}$. Thus $\sqrt[3]{-\frac{8}{27}} = -\frac{2}{3}$, the unique real number with the verified cube.

### Problem 8

**1.** The principal root is $\sqrt{64} = 8$, because $8^2 = 64$. The equation asks for every real number whose square is $64$.

**2.** Both signs work: $8^2 = 64$ and $(-8)^2 = 64$. Thus $x = \pm 8$; unlike the principal-root symbol alone, the equation has two solutions.

### Problem 9

**1.** Take the real cube root of both sides: $y = \sqrt[3]{-125}$. A negative radicand has a negative real cube root.

**2.** Check $(-5)(-5)(-5) = 25(-5) = -125$. Hence $y = -5$, and no positive value can cube to the negative number $-125$.

### Problem 10

**1.** Compute the two roots separately: $12^2 = 144$ gives $\sqrt{144} = 12$, and $3^3 = 27$ gives $\sqrt[3]{27} = 3$.

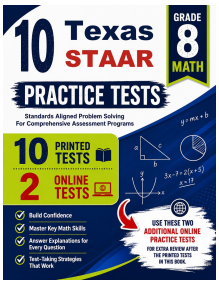
**2.** Substitute before subtracting: $12 - 3 = 9$. The square and cube roots use different indices, so subtracting radicands first would not represent the original expression.

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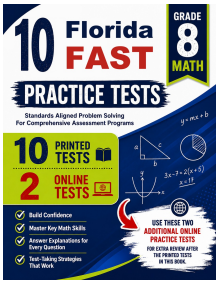

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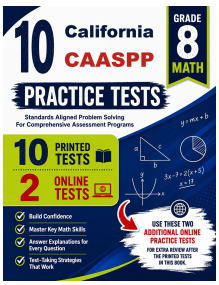

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