

8.4 Adding and Subtracting Radical Expressions

Objective

- 1 Simplify radical expressions involving addition and subtraction.

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Simplify radical expressions involving addition and subtraction.

CAUTION Only radical expressions with the same index and the same radicand may be combined. Expressions such as $3\sqrt{3} + 2\sqrt[3]{3}$ or $5\sqrt{3} + 2\sqrt{2}$ cannot be simplified by combining terms.

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CLASSROOM EXAMPLE 1 Adding and Subtracting Radicals

Add or subtract to simplify each radical expression.

Solution:

$$3\sqrt{5} + 7\sqrt{5} = (3+7)\sqrt{5} = 10\sqrt{5}$$

$$\begin{aligned} 2\sqrt{11} - \sqrt{11} + 3\sqrt{44} &= 2\sqrt{11} - \sqrt{11} + 3\sqrt{4} \cdot \sqrt{11} \\ &= 2\sqrt{11} - 1\sqrt{11} + 3 \cdot 2 \cdot \sqrt{11} \\ &= (2-1+6)\sqrt{11} \\ &= 7\sqrt{11} \end{aligned}$$

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CLASSROOM EXAMPLE 1 Adding and Subtracting Radicals (cont'd)

Add or subtract to simplify each radical expression.

Solution:

$$\begin{aligned} 5\sqrt{12y} + 6\sqrt{75y}, y \geq 0 &= 5\sqrt{4} \cdot \sqrt{3y} + 6\sqrt{25} \cdot \sqrt{3y} \\ &= 5 \cdot 2\sqrt{3y} + 6 \cdot 5\sqrt{3y} \\ &= 10\sqrt{3y} + 30\sqrt{3y} \\ &= (10+30)\sqrt{3y} \\ &= 40\sqrt{3y} \end{aligned}$$

$$9\sqrt{5} - 4\sqrt{10}$$

This expression can not be simplified any further.

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Simplify radical expressions involving addition and subtraction.

CAUTION Do not confuse the product rule with combining like terms. **The root of a sum does not equal the sum of the roots.** For example $\sqrt{9+16} \neq \sqrt{9} + \sqrt{16}$

since $\sqrt{9+16} = \sqrt{25} = 5$, but $\sqrt{9} + \sqrt{16} = 3 + 4 = 7$.

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CLASSROOM EXAMPLE 2 Adding and Subtracting Radicals with Higher Indexes

Add or subtract to simplify the radical expression. Assume that all variables represent positive real numbers.

Solution:

$$\begin{aligned} -2\sqrt[4]{32} - 7\sqrt[4]{162} &= -2\sqrt[4]{16 \cdot 2} - 7\sqrt[4]{81 \cdot 2} \\ &= -2 \cdot 2\sqrt[4]{2} - 7 \cdot 3\sqrt[4]{2} \\ &= -4\sqrt[4]{2} - 21\sqrt[4]{2} \\ &= -25\sqrt[4]{2} \end{aligned}$$

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CLASSROOM EXAMPLE 2 Adding and Subtracting Radicals with Higher Indexes (cont'd)

Add or subtract to simplify the radical expression. Assume that all variables represent positive real numbers.

Solution:

$$\begin{aligned}\sqrt[3]{p^4q^7} - \sqrt[3]{64pq} &= \sqrt[3]{p^3q^6 \cdot pq} - \sqrt[3]{64 \cdot pq} \\ &= pq^2\sqrt[3]{pq} - 4\sqrt[3]{pq} \\ &= (pq^2 - 4)\sqrt[3]{pq}\end{aligned}$$

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CLASSROOM EXAMPLE 2 Adding and Subtracting Radicals with Higher Indexes (cont'd)

Add or subtract to simplify the radical expression. Assume that all variables represent positive real numbers.

Solution:

$$\begin{aligned}6\sqrt[3]{16z^7} + 4\sqrt{200z^5} &= 6\sqrt[3]{8z^6 \cdot 2z} + 4\sqrt{100z^4 \cdot 2z} \\ &= 6\sqrt[3]{8z^6} \cdot \sqrt[3]{2z} + 4\sqrt{100z^4} \cdot \sqrt{2z} \\ &= 6 \cdot 2z^2\sqrt[3]{2z} + 4 \cdot 10z^2\sqrt{2z} \\ &= 12z^2\sqrt[3]{2z} + 40z^2\sqrt{2z}\end{aligned}$$

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CLASSROOM EXAMPLE 3 Adding and Subtracting Radicals with Fractions

Perform the indicated operations. Assume that all variables represent positive real numbers.

Solution:

$$\begin{aligned}2\sqrt{\frac{32}{36}} + 2\frac{\sqrt{27}}{\sqrt{108}} &= 2\frac{\sqrt{16 \cdot 2}}{\sqrt{36}} + 2\frac{\sqrt{9 \cdot 3}}{\sqrt{36 \cdot 3}} \\ &= 2\left(\frac{4\sqrt{2}}{6}\right) + 2\left(\frac{3\sqrt{3}}{6\sqrt{3}}\right) \\ &= \frac{4\sqrt{2}}{3} + \frac{3}{3} = \frac{4\sqrt{2} + 3}{3}\end{aligned}$$

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CLASSROOM EXAMPLE 3 Adding and Subtracting Radicals with Fractions (cont'd)

Perform the indicated operations. Assume that all variables represent positive real numbers.

Solution:

$$\begin{aligned}\sqrt{\frac{80}{y^4}} + \sqrt{\frac{81}{y^{10}}} &= \frac{\sqrt{16 \cdot 5}}{\sqrt{y^4}} + \frac{\sqrt{81}}{\sqrt{y^{10}}} \\ &= \frac{4\sqrt{5}}{y^2} + \frac{9}{y^5} \\ &= \frac{4y^3\sqrt{5}}{y^5} + \frac{9}{y^5} = \frac{4y^3\sqrt{5} + 9}{y^5}\end{aligned}$$

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