## 9.1 Start Thinking

Simplify $\sqrt{360}$ using the steps below.

**Step 1** Make a list of factors of 360.

**Step 2** Find the greatest perfect square factor.

**Step 3** Rewrite the radical as the product of the perfect square factor and its pair.

**Step 4** Separate the product as two radicals.

**Step 5** Simplify the square root radical.

**Step 6** Write the answer as the product of a whole number and a radical.

## 9.1 Warm Up

**Simplify.**

**1.** $\sqrt{16}$ **2.** $\sqrt{64}$ **3.** $\sqrt{225}$

**4.** $\sqrt{2025}$ **5.** $\sqrt{57{,}600}$ **6.** $\sqrt{36}$

**7.** $\sqrt{400}$ **8.** $\sqrt{4}$ **9.** $\sqrt{3600}$

## 9.1 Cumulative Review Warm Up

**Determine whether the function represents *exponential growth* or *exponential decay*. Identify the percent rate of change.**

**1.** $y = 5(0.7)^t$ **2.** $y = 49(1.04)^t$

**3.** $r(t) = 0.5(0.95)^t$ **4.** $g(t) = 3\left(\frac{4}{5}\right)^t$

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# 9.1 Practice A

**In Exercises 1–9, simplify the expression.**

**1.** $\sqrt{50}$

**2.** $\sqrt{68}$

**3.** $-\sqrt{98}$

**4.** $\sqrt{\frac{9}{25}}$

**5.** $-\sqrt{\frac{3}{64}}$

**6.** $-\sqrt{\frac{x^2}{4}}$

**7.** $\sqrt[3]{24}$

**8.** $\sqrt[3]{-250}$

**9.** $-\sqrt[3]{128x^4}$

**10.** Describe and correct the error in simplifying the expression.

$\times \quad \sqrt[3]{16} = 4$

**In Exercises 11–13, write a factor that you can use to rationalize the denominator of the expression.**

**11.** $\frac{3}{\sqrt{5}}$

**12.** $\frac{1}{\sqrt{7n}}$

**13.** $\frac{5}{\sqrt[3]{9}}$

**In Exercises 14–22, simplify the expression.**

**14.** $\frac{3}{\sqrt{3}}$

**15.** $\frac{9}{\sqrt{5}}$

**16.** $\frac{\sqrt{3}}{\sqrt{50}}$

**17.** $\frac{4}{\sqrt{w}}$

**18.** $\frac{1}{\sqrt{5t}}$

**19.** $\sqrt{\frac{2z^2}{7}}$

**20.** $\frac{1}{\sqrt{6}-1}$

**21.** $\frac{3}{4+\sqrt{2}}$

**22.** $\frac{\sqrt{3}}{5-\sqrt{2}}$

**23.** The average annual interest rate $r$ (in decimal form) of a savings account is represented by the formula $r = \sqrt{\frac{V_2}{V_0}} - 1$, where $V_0$ is the initial investment and $V_2$ is the balance of the account after 2 years. Find the average annual interest rate $r$ of a savings account with an initial investment of \$400 and a balance of \$422 after 2 years.

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# 9.1 Practice B

**In Exercises 1–9, simplify the expression.**

**1.** $\sqrt{54}$

**2.** $\sqrt{25y^2}$

**3.** $-\sqrt{18n^3}$

**4.** $\sqrt{\frac{29}{100}}$

**5.** $\sqrt{\frac{p^3}{49}}$

**6.** $\sqrt{\frac{36}{9x^2}}$

**7.** $\sqrt[3]{32q^2}$

**8.** $\sqrt[3]{\frac{9d}{-8}}$

**9.** $-\sqrt[3]{\frac{60x^2}{729y^3}}$

**10.** Describe and correct the error in simplifying the expression.

$$\sqrt{\frac{30}{25}} = \sqrt{\frac{6}{5}}$$
$$= \frac{\sqrt{6}}{\sqrt{5}}$$

**In Exercises 11–13, write a factor that you can use to rationalize the denominator of the expression.**

**11.** $\frac{2}{\sqrt{7y}}$

**12.** $\frac{8}{\sqrt[3]{k^2}}$

**13.** $\frac{2}{3 - \sqrt{6}}$

**In Exercises 14–22, simplify the expression.**

**14.** $\frac{4}{\sqrt{3}}$

**15.** $\frac{\sqrt{2}}{\sqrt{45}}$

**16.** $\frac{1}{\sqrt{6t}}$

**17.** $\sqrt{\frac{5h^2}{7}}$

**18.** $\frac{\sqrt{27}}{\sqrt{2d^3}}$

**19.** $\frac{25}{\sqrt[3]{4}}$

**20.** $\frac{5}{7 - \sqrt{2}}$

**21.** $\frac{\sqrt{3}}{8 + \sqrt{7}}$

**22.** $\frac{\sqrt{5}}{\sqrt{5} - \sqrt{7}}$

**23.** Use the special product pattern $(a - b)(a^2 + ab + b^2) = a^3 - b^3$ to simplify the expression $\frac{3}{\sqrt[3]{x} - 1}$.

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# 9.1 Enrichment and Extension

## Simplify Radicals With Imaginary Numbers

Think about the equation $x^2 = -1$ and notice that there is nothing that can make the equation true while using real numbers. It is not possible to substitute any real number for $x$ that will yield a solution of $-1$. This is where imaginary numbers come in. Use the definition $i = \sqrt{-1}$ when simplifying radicals of negative numbers.

**Example:** Simplify $\sqrt{-120x^2y^3}$.

$$\sqrt{-120x^2y^3} = \sqrt{-1 \bullet 4 \bullet 30 \bullet x^2 \bullet y^2 \bullet y} = 2ixy\sqrt{30y}$$

**Simplify the expression using the definition $i = \sqrt{-1}$.**

**1.** $\sqrt{-80}$

**2.** $\sqrt{-50xy^2}$

**3.** $\sqrt{-216}$

**4.** $\sqrt{-32w^2z^4}$

**5.** $\sqrt{-175pqr^6}$

**6.** $\sqrt{-22x^3}$

**7.** $\dfrac{\sqrt{-15}}{\sqrt{3}}$

**8.** $\dfrac{2\sqrt{-21}}{\sqrt{7}}$

**9.** $\dfrac{\sqrt{-2}}{\sqrt{5}}$

**10.** $\sqrt{-8} \bullet \sqrt{5}$

**11.** $\sqrt{3} \bullet \sqrt{-27}$

**12.** $\sqrt{-2xy} \bullet \sqrt{30x^2y}$

**13.** $\dfrac{-3\sqrt{-20}}{2\sqrt{8}}$

**14.** $\dfrac{3}{\sqrt{-2}}$

**15.** $\dfrac{-\sqrt{-12xy^3}}{\sqrt{6x^3y}}$

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# 9.1 Puzzle Time

## What Do You Say When You Get Off A Boat?

Write the letter of each answer in the box containing the exercise number.

**Simplify the expression.**

**1.** $\sqrt{28}$

**2.** $-\sqrt{75}$

**3.** $\sqrt{63x^3}$

**4.** $-\sqrt{\dfrac{36x^2}{121}}$

**5.** $\sqrt{\dfrac{x^5}{64}}$

**6.** $\sqrt[3]{-54}$

**7.** $-\sqrt[3]{\dfrac{125x^2}{343y^3}}$

**8.** $\sqrt[3]{\dfrac{729}{-1000x^3y^6}}$

**9.** $\dfrac{6}{\sqrt{11}}$

**10.** $\sqrt{\dfrac{8}{28}}$

**11.** $\dfrac{\sqrt{12}}{\sqrt{5x^3}}$

**12.** $\dfrac{2}{\sqrt{13}+1}$

**13.** $\dfrac{\sqrt{7}}{9+\sqrt{7}}$

**14.** $\sqrt{2} - 3\sqrt{17} + 7\sqrt{2}$

**15.** $8\sqrt{24} - 6\sqrt{54}$

**16.** $\left(\sqrt{10} + \sqrt{40}\right)\left(\sqrt{50} - \sqrt{18}\right)$

**17.** The length of the board for a shelf is $\left(\sqrt{27} + \sqrt{3}\right)$ feet. The width of the board is $2\sqrt{2}$ feet. Find the area of the board.

**Answers**

**U.** $-\dfrac{5\sqrt[3]{x^2}}{7y}$

**R.** $3x\sqrt{7x}$

**N.** $\dfrac{x^2\sqrt{x}}{8}$

**M.** $-\dfrac{9}{10xy^2}$

**T.** $8\sqrt{6}$

**Y.** $\dfrac{6\sqrt{11}}{11}$

**C.** $\dfrac{-1+\sqrt{13}}{6}$

**H.** $-2\sqrt{6}$

**O.** $-5\sqrt{3}$

**E.** $2\sqrt{7}$

**H.** $12\sqrt{5}$

**A.** $\dfrac{-7+9\sqrt{7}}{74}$

**F.** $8\sqrt{2} - 3\sqrt{17}$

**R.** $-3\sqrt[3]{2}$

**K.** $\dfrac{\sqrt{14}}{7}$

**Y.** $\dfrac{2\sqrt{15x}}{5x^2}$

**U.** $-\dfrac{6x}{11}$

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| 17 | 15 | 13 | 5 | 10 | | 11 | 2 | 7 | | 14 | 1 | 6 | 3 | 9 | | 8 | 4 | 12 | 16 |