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WARM-UPS

6. $m^{-2}n^0$ $\frac{1}{m^2}$ $\frac{1}{m^2}$

8. $db^{-1}c^2$ $\frac{dc^2}{b^1}$

9. $d^2d^6$ $d^8$

14. $\frac{c^7}{c^1}$ $c^6$

20. $\left(\frac{xz}{y}\right)^6$ $\frac{x^6z^6}{y^6}$

21. $(c^3)^4$ $c^{12}$

24. $(p^5)^{-2}$ $p^{-10}$ $= \frac{1}{p^{10}}$

26. $(x^{-2})^3$ $\frac{1}{x^6}$ $x^{-6}$

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8-4

# Day 9

1/22

# Properties of Logarithms

## Check Skills You'll Need

$3^x = 9$ $3^3 = 27$

**Simplify each expression.**

1. $\log_2 4 + \log_2 8$ $2 + 3$ $5$

2. $\log_3 9 - \log_3 27$ $2 - 3$ $-1$

3. $\log_2 16 \div \log_2 64$ $4 \div 6 = 2/3$

## What You'll Learn

- To use the properties of logarithms

## . . . And Why

To relate sound intensity and decibel level, as in Example 4

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## Check Skills You'll Need

$c$ exponent / root

**Rewrite the radical expression with a rational exponent.**

root / exponent

$\sqrt[4]{c^2} = c^{\frac{2}{4}} = c^{\frac{1}{2}}$

$\sqrt[2]{7^1 x^3} = 7^{\frac{1}{2}} x^{\frac{3}{2}}$

$\sqrt{-10} = (-10)^{1/2}$

$\sqrt[3]{a^2}$ $a^{\frac{2}{3}}$

$-\sqrt{10}$ $-10^{1/2}$

$\sqrt{6} = 6^{1/2}$

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**Properties** | **Properties of Logarithms**

For any positive numbers, $M$, $N$, and $b$, $b \neq 1$,

### 1. Product Property

$$\log_b MN = \boxed{\phantom{xxxx}}$$

example

3 Expand each logarithm.

a. $\log_2 7b = \log_2 7 + \log_2 b$

b. $\log_7 22xyz$

$\log_7 22 + \log_7 x + \log_7 y + \log_7 z$

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## 2. Quotient Property

$$\log_b \frac{M}{N} = \square$$

top

Bottom

example

Expand each logarithm.

**a.** $\log_5 \frac{x}{y} = \log_5 x - \log_5 y$

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## 3. Power Property

$$\log_b M^x = \square$$

to condense move # in front to an exponent

expand

move the exponent in front of the logarithm

examples

**c.** $\log_7 a^3 b^4$

$\log_7 a^3 + \log_7 b^4$

$3\log_7 a + 4\log_7 b$

$3\log_7 a + 4\log_7 b$

**d.** $\log_8 8\sqrt{3a^5}$

$\log_8 8 \cdot 3^{\frac{1}{2}} \cdot a^{\frac{5}{2}}$

$\sqrt[2]{3a^5}$

$3^{\frac{1}{2}} a^{\frac{5}{2}}$

$\log_8 8 + \log_8 3^{\frac{1}{2}} + \log_8 a^{\frac{5}{2}}$

$\log_8 8 + \frac{1}{2}\log_8 3 + \frac{5}{2}\log_8 a$

$1 + \frac{1}{2}\log_8 3 + \frac{5}{2}\log_8 a$

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**1** State the property or properties used to rewrite each expres

**a.** $\log_5 2 + \log_5 6 = \log_5 12$

$2 \cdot 6$ → Product

**b.** $3\log_b 4 - 3\log_b 2 = \log_b 8$

$\log_b 64 - \log_b 8$ Quotient Power

$\log_6 \frac{64}{8}$

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Condense

**Quick Check** **2** **a.** Write $3 \log 2 + \log 4 - \log 16$ as a single logarithm.

$\log 2^3 + \log 4 - \log 16$

$\log 8 + \log 4 - \log 16$

$\log (8 \cdot 4)$

$\log 32 - \log 16$

$\log \frac{32}{16} = \log 2$

**b.** **Critical Thinking** Can you write $3 \log_2 9 - \log_6 9$ as a single logarithm? Explain.

No, Bases aren't the same

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Write each expression in expanded form.

1. $\log_2 \frac{x}{y}$ $\log_2 x - \log_2 y$

2. $\log_5 12cd$ $\log_5 12 + \log_5 c + \log_5 d$

3. $\log_3 \frac{4a}{3}$ $\log_3 4a - \log_3 3$ $\log_3 4 + \log_3 a - 1$

4. $\log_b \frac{2k}{3m}$ $\log_b 2k - \log_b 3m$

- $\log_b 2 + \log_b K - (\log_b 3 + \log_b m)$
- $\log_b 2 + \log_b K - \log_b 3 - \log_b m$

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Simplify each expression.

6. $\log_4 12 + \log_4 2a$ $12 \cdot 2a$ multiply $= \log_4 (12 \cdot 2a)$ $\log_4 24a$

7. $\log_b t - \log_b v + \log_b u$ subtract → $\div$ $\frac{t}{v} \cdot u$

$\log_b \frac{t}{v} + \log_b u = \log_b \frac{tu}{v}$ ↑ multiply

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8. $\log_3 6x - \log_3 4y + \log_3 12y - \log_3 2x$

9. $\log_b 5 + \log_b x - \log_b 10y + \log_b 2y$

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10. $\log_2 12 - \log_2 3a + \log_2 a^2 - \log_2 10$

$\log_2 \frac{12}{3a} + \log_2 a^2$

$\log_2 \frac{12}{3a} \cdot a^2 - \log_2 10$

$\log_2 4a - \log_2 10 = \log_2 \frac{4a}{10}$

$\log_2 \frac{2a}{5}$

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