

# Properties of Logarithms

Algebra Worksheet · Grade 10–12

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Learning Objectives

- Apply the addition, subtraction, and power properties of logarithms to expand expressions
- Condense multiple logarithmic terms into a single logarithm using log properties
- Combine all three properties to simplify complex logarithmic expressions

## Problems

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1. Use the addition property to expand the following logarithm.

$$\log_5 (3x)$$

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2. Use the subtraction property to expand the following logarithm.

$$\log_4 \left(\frac{x}{9}\right)$$

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3. Use the power property to expand the following logarithm.

$$\log_3 (x^5)$$

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4. Use the addition and power properties to fully expand the following logarithm.

$$\log_6 (4x^3)$$

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5. Condense the following expression into a single logarithm using the addition property.

$$\log_7 (x) + \log_7 (y)$$

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6. Condense the following expression into a single logarithm using the subtraction property.

$$\log_{11} (x) - \log_{11} (5)$$

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7. Condense the following expression into a single logarithm.

$$3\log_2(x) + \log_2(5)$$

8. Fully expand the following logarithm using all necessary properties. The base is 10 (common log).

$$\log\left(\frac{x^2y}{z^3}\right)$$

9. Condense the following into a single logarithm.

$$2\log_8(x) - 4\log_8(y) + \log_8(3)$$

10. Fully expand the following complex logarithm.

$$\log_8\left(\frac{4(x-5)^2}{x^4(x-3)^3}\right)$$

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# Properties of Logarithms — Answer Key

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## Answer Key

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### 1. Answer: $\log_5(3) + \log_5(x)$

- Apply the addition property:  $\log_B(M \cdot N) = \log_B(M) + \log_B(N)$
- Split  $3x$  into two factors:  $\log_5(3) + \log_5(x)$

### 2. Answer: $\log_4(x) - \log_4(9)$

- Apply the subtraction property:  $\log_B(M/N) = \log_B(M) - \log_B(N)$
- Result:  $\log_4(x) - \log_4(9)$

### 3. Answer: $5 \log_3(x)$

- Apply the power property:  $\log_B(M^n) = n \cdot \log_B(M)$
- Bring the exponent 5 in front:  $5 \cdot \log_3(x)$

### 4. Answer: $\log_6(4) + 3 \log_6(x)$

- Apply the addition property:  $\log_6(4) + \log_6(x^3)$
- Apply the power property to  $\log_6(x^3)$ :  $\log_6(4) + 3 \cdot \log_6(x)$

### 5. Answer: $\log_7(xy)$

- Apply the addition property in reverse:  $\log_B(M) + \log_B(N) = \log_B(M \cdot N)$
- Combine:  $\log_7(x \cdot y) = \log_7(xy)$

### 6. Answer: $\log_{11}(x/5)$

- Apply the subtraction property in reverse:  $\log_B(M) - \log_B(N) = \log_B(M/N)$
- Combine:  $\log_{11}(x/5)$

### 7. Answer: $\log_2(5x^3)$

- Apply the power property in reverse to  $3 \cdot \log_2(x)$ :  $\log_2(x^3)$
- Apply the addition property:  $\log_2(x^3) + \log_2(5) = \log_2(5x^3)$

### 8. Answer: $2 \log(x) + \log(y) - 3 \log(z)$

- Apply the subtraction property:  $\log(x^2 \cdot y) - \log(z^3)$
- Apply the addition property to the numerator:  $\log(x^2) + \log(y) - \log(z^3)$
- Apply the power property:  $2 \cdot \log(x) + \log(y) - 3 \cdot \log(z)$

### 9. Answer: $\log_8(3x^2 / y^4)$

- Apply the power property:  $\log_8(x^2) - \log_8(y^4) + \log_8(3)$
- Apply the addition property:  $\log_8(3x^2) - \log_8(y^4)$
- Apply the subtraction property:  $\log_8(3x^2 / y^4)$

### 10. Answer: $\log_8(4) + 2 \cdot \log_8(x-5) - 4 \cdot \log_8(x) - 3 \cdot \log_8(x-3)$

- Apply the subtraction property:  $\log_8[4(x-5)^2] - \log_8[x^4(x-3)^3]$

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- Expand the numerator using the addition property:  $\log_8(4) + \log_8[(x-5)^2]$
  - Expand the denominator using the addition property:  $\log_8(x^4) + \log_8[(x-3)^3]$
  - Apply the power property throughout:  $\log_8(4) + 2 \cdot \log_8(x-5) - [4 \cdot \log_8(x) + 3 \cdot \log_8(x-3)]$
  - Distribute the negative sign:  $\log_8(4) + 2 \cdot \log_8(x-5) - 4 \cdot \log_8(x) - 3 \cdot \log_8(x-3)$
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