

10-3 Properties of Logarithms - Microsoft Word

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10.3. Advanced Algebra Properties of Logarithms

DATE: 12/9

*Target 4E. Solve exponential and logarithmic equations.
Target 4F. Condense and expand logarithms using logarithmic properties.*



Since logarithms are exponents, the properties of logarithms are derived from the properties of exponents.

Product Property of Logarithms:

Use the N-spire to evaluate the logarithmic expressions below:

1a) $\log_2(4 \cdot 16) = 6$

1b) $\log_2 4 + \log_2 16 = 6$

2a) $\log_3(27 \cdot 9) = 5$

2b) $\log_3 27 + \log_3 9 = 5$

3a) $\log_5(25 \cdot 15,625) = 8$

3b) $\log_5 25 + \log_5 15,625 = 8$

Conclusion: The logarithm of a product is the sum of the logarithms of its factors. In symbols, for all positive numbers m , n , and b , where $b \neq 1$,

$$\log_b(m \cdot n) = \log_b m + \log_b n$$

Expand the following Logarithms:

1. $\log_2 7x$ $\log_2 7 + \log_2 x$

2. $\log_6 2ab$ $\log_6 2 + \log_6 a + \log_6 b$

Condense the following Logarithms:

3. $\log_3 4 + \log_3 m$

$$\log_3 4m$$

4. $\log_9 3 + \log_9 5 + \log_9 u + \log_9 v$

$$\log_9 3 \cdot 5 \cdot u \cdot v = \log_9 15uv$$

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Quotient Property of Logarithms:

Use the N-spire to evaluate the logarithmic expressions below:

1a) $\log_2 \frac{16}{4} = 2$

1b) $\log_2 16 - \log_2 4 = 2$

2a) $\log_3 \left(\frac{27}{9}\right) = 1$

2b) $\log_3 27 - \log_3 9 = 1$

3a) $\log_5 \left(\frac{15,625}{25}\right) = 4$

3b) $\log_5 15,625 - \log_5 25 = 4$

Conclusion: The logarithm of a Quotient is the difference of the logarithms of numerator and denominator. In symbols, for all positive numbers m , n , and b , where $b \neq 1$,

$$\log_b \left(\frac{m}{n} \right) = \log_b m - \log_b n$$

Expand the following Logarithms:

5. $\log_2 \frac{7}{x}$

$$\log_2 7 - \log_2 x$$

6. $\log_6 \frac{2a}{b}$

$$\begin{aligned} & \log_2 2a - \log_2 b \\ &= \log_2 2 + \log_2 a - \log_2 b \end{aligned}$$

Condense the following Logarithms:

7. $\log_3 4 - \log_3 m$

$$\log_3 \frac{4}{m}$$

8. $\log_9 15 - \log_9 3$

$$\log_9 \frac{15}{3} = \log_9 5$$

Power Property of Logarithms:

Use the N-spire to evaluate the logarithmic expressions below:

1a) $\log_4 4^3 =$

1b) $3 \cdot \log_4 4 =$

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Power Property of Logarithms:
Use the N-spire to evaluate the logarithmic expressions below:

1a) $\log_2 4^6 = 6$ 1b) $3 \log_2 4 = 6$
2a) $\log_3 27^5 = 5$ 2b) $17 \log_3 27 = 51$
3a) $\log_5 15,625 = 4$ 3b) $4 \log_5 15,625 = 24$

Conclusion: The logarithm of a power is the product of the logarithm and the exponent. In symbols, for any real number p and positive numbers m and b , where $b \neq 1$,

$$\log_b m^p = p \cdot \log_b m$$

Expand the following Logarithms:

9. $\log_2 5^x$ 10. $\log_6 x^5$

$x \cdot \log_2 5$ $5 \cdot \log_6 x$

Condense the following Logarithms:

11. $2 \log_3 7 - \log_3 m$

$$\log_2 7^2 - \log_3 m = \log_2 \frac{7^2}{m}$$
$$= \log_2 \frac{49}{m}$$

12. $3 \log_9 (4x) + \log_9 3$

$$\log_9 (4x)^3 + \log_9 3$$
$$\log_9 4^3 x^3 + \log_9 3$$
$$= \log_9 (4^3 \cdot x^3) = \log_9 192x^3 \checkmark$$

Solve Equations Using Properties of Logarithms

Solve each equation.

13. $3 \log_5 x - \log_5 4 = \log_5 16$

$$\log_5 x^3 - \log_5 4 = \log_5 16$$
$$\cancel{\log_5} \frac{x^3}{4} = \cancel{\log_5} 16$$

14. $\log_4 x + \log_4 (x-6) = 2$

$$\log_4 x \cdot (x-6) = 2$$

$4^2 = x(x-6)$
 $16 = x^2 - 6x$
 $0 = x^2 - 6x - 16$
 $0 = (x-8)(x+2)$

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