MATHEMATICS · GRADES 10-12

Expanding logarithmic expressions

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you break apart a logarithm that measures something like the loudness of a sound or the strength of an earthquake into simpler parts you can work out. A single logarithm can hide a multiplication or a power inside it, and expanding it pulls those pieces apart. Each piece is then easy to work out on its own. It turns one hard logarithm into a few easy ones.



Rule

Logarithm laws: $\log(xy) = \log x + \log y$, $\log(\frac{x}{y}) = \log x - \log y$, and $\log(x^n) = n \log x$.

Use these to break a logarithm apart into simpler parts.

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Worked examples

EXAMPLE 1

Q Expand $\log(x^2 \times y)$

SOLUTION

Use the product law first: $\log(x^2 \times y) = \log(x^2) + \log(y)$

Use the power law on the first part: $\log(x^2) = 2 \times \log(x)$

So the expansion is $2 \times \log(x) + \log(y)$

EXAMPLE 2

Q Expand $\log\left(\frac{x}{y^3}\right)$

SOLUTION

Use the quotient law: $\log\left(\frac{x}{y^3}\right) = \log(x) - \log(y^3)$

Use the power law: $\log(y^3) = 3 \times \log(y)$

So the expansion is $\log(x) - 3 \times \log(y)$

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Practice questions

1 Expand $\log(x \times y)$.

- **A** $\log(x) - \log(y)$
- **B** $\log(x) + \log(y)$
- **C** $\log(x) \times \log(y)$
- **D** $\log(x + y)$

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2 Expand $\log(x^3)$.

- **A** $(\log(x))^3$
- **B** $3 \times \log(x)$
- **C** $\log(x) + 3$
- **D** $\log(x) \div 3$

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3 Expand $\log(\frac{x}{y})$.

- **A** log(x) + log(y)
- **B** log(y) - log(x)
- **C** log(x) - log(y)
- **D** log(x) ÷ log(y)

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4 Expand $\log(x^2 \times y^3)$.

- **A** 2 × log(x) - 3 × log(y)
- **B** 3 × log(x) + 2 × log(y)
- **C** 2 × log(x) + 3 × log(y)
- **D** log(x) + log(y)

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5 Expand $\log(\frac{x^4}{y})$.

A 4 × log(x) + log(y)

B log(y) - 4 × log(x)

C 4 × log(x) - log(y)

D 4 × log(x) - 4 × log(y)

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6 Expand $\log(\frac{(x \times y)}{z})$.

A log(x) + log(y) + log(z)

B log(x) - log(y) - log(z)

C log(x) + log(y) - log(z)

D log(z) - log(x) - log(y)

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7 Expand $\log(\frac{x^2y}{z})$.

- **A** 2 × log(x) - log(y) + log(z)
- **B** log(x) + log(y) - log(z)
- **C** 2 × log(x) + log(y) - log(z)
- **D** 2 × log(x) + log(y) + log(z)

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8 Expand $\log(\frac{y}{x^2})$.

- **A** 2 × log(x) - log(y)
- **B** log(y) + 2 × log(x)
- **C** log(y) - 2 × log(x)
- **D** log(y) - log(x)

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9 Expand $\log((\frac{x}{y})^3)$.

A $3 \times \log(x) + 3 \times \log(y)$

B $3 \times \log(x) - 3 \times \log(y)$

C $\log(x) - \log(y)$

D $(\log(x) - \log(y))^3$

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10 Expand $\log(\frac{x^2}{y^3})$.

A $3 \times \log(x) - 2 \times \log(y)$

B $2 \times \log(x) + 3 \times \log(y)$

C $2 \times \log(x) - 3 \times \log(y)$

D $\log(x) - \log(y)$

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ANSWER KEY

1. $\log(x) + \log(y)$

2. $3 \times \log(x)$

3. $\log(x) - \log(y)$

4. $2 \times \log(x) + 3 \times \log(y)$

5. $4 \times \log(x) - \log(y)$

6. $\log(x) + \log(y) - \log(z)$

7. $2 \times \log(x) + \log(y) - \log(z)$

8. $\log(y) - 2 \times \log(x)$

9. $3 \times \log(x) - 3 \times \log(y)$

10. $2 \times \log(x) - 3 \times \log(y)$

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