MATHEMATICS · GRADES 10-12

Logarithm laws

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you split or combine logs to simplify a calculation, the way a scientist shortens a formula for earthquake strength or sound level before using it. Log laws let you trade a long, messy calculation for a short one that gives the same answer, which is why scientists and engineers rely on them. You meet them in formulas for earthquake size, sound loudness, and acidity, where the numbers would be unmanageable without logs to shrink them down.



Rule

Logarithm laws: log of a product is the sum of the logs, log(a × b) = log a + log b.

Log of a quotient is the difference of the logs, $\log(\frac{a}{b}) = \log a - \log b$. Log of a power brings the exponent out front, $\log(a^n) = n \log a$.

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Worked examples

EXAMPLE 1

Q Use the laws to simplify $\log\left(\frac{100}{10}\right)$

SOLUTION

Use the quotient law: $\log\left(\frac{100}{10}\right) = \log(100) - \log(10)$

Evaluate each part: $\log(100) = 2$ and $\log(10) = 1$

Subtract: $2 - 1 = 1$

EXAMPLE 2

Q Use the laws to simplify $\log(2^3)$

SOLUTION

Use the power law: $\log(2^3) = 3 \times \log(2)$

This is the simplified form using the power law.

Note that it is not a whole number, and that is fine: the law gives the form, not a decimal.

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Practice questions

1 Simplify $\log(100 \times 10)$ using the product law, then evaluate.

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2 Simplify $\log(\frac{1000}{100})$ using the quotient law, then evaluate.

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3 Simplify $\log(10^4)$ using the power law, then evaluate.

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4 Write $\log(2 \times 3)$ using the product law.

- **A** $\log(2) + \log(3)$
- **B** $\log(2) - \log(3)$
- **C** $\log(2) \times \log(3)$
- **D** $\log(6) + \log(1)$

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5 Write $\log(\frac{8}{2})$ using the quotient law.

- **A** $\log(8) + \log(2)$
- **B** $\log(8) - \log(2)$
- **C** $\log(8) \div \log(2)$
- **D** $\log(4) - \log(1)$

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6 Write $\log(5^2)$ using the power law.

A $\log(5) \div 2$

B $2 \times \log(5)$

C $\log(5) + 2$

D $5 \times \log(2)$

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7 Simplify $\log(100) + \log(10)$.

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8 Simplify $\log(1000) - \log(10)$.

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9 Which law lets you simplify log(100) – log(10)?

- A Product law
- B Quotient law
- C Power law
- D Change-of-base law

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10 Simplify 2 × log(10).

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ANSWER KEY

1. 3

2. 1

3. 4

4. log(2) + log(3)

5. log(8) - log(2)

6. 2 × log(5)

7. 3

8. 2

9. Quotient law

10. 2

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