

Exponential and Logarithmic Equations



Lesson Vocabulary

- exponential equation
- logarithmic equation

Objective To solve exponential and logarithmic equations

Exponential Equations

$$16^{3x} = 8?$$

$$15^{3x} = 285?$$

Logarithmic Equations

$$\log(4x - 3) = 2?$$

$$\log(x - 3) + \log x = 1?$$

Essential Understanding You can use logarithms to solve exponential equations. You can use exponents to solve logarithmic equations.

Exponential and Logarithmic Equations

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Remember?

take note

Properties Properties of Logarithms

For any positive numbers m , n , and b where $b \neq 1$, the following properties apply.

Product Property $\log_b mn = \log_b m + \log_b n$

Quotient Property $\log_b \frac{m}{n} = \log_b m - \log_b n$

Power Property $\log_b m^n = n \log_b m$

Exponential and Logarithmic Equations

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What is the solution of $16^{3x} = 8$?

$$16^{3x} = 8$$

$$(2^4)^{3x} = 2^3 \quad \text{Rewrite the terms with a common base.}$$

$$2^{12x} = 2^3 \quad \text{Power Property of Exponents}$$

$$12x = 3 \quad \text{If two numbers with the same base are equal, their exponents are equal.}$$

$$x = \frac{1}{4} \quad \text{Solve and simplify.}$$

Exponential and Logarithmic Equations



Got It?

1. What is the solution of $27^{3x} = 81$?

$$3^3 = 27 \quad 3^4 = 81$$

Rewrite the equation as:

$$(3^3)^{3x} = 3^4$$

$$3^{9x} = 3^4$$

Since the bases are the same so

$$9x = 4$$

$$x = \frac{4}{9}$$

Exponential and Logarithmic Equations



Problem 2 Solving an Exponential Equation – Different Bases

What is the solution of $15^{3x} = 285$?

$$15^{3x} = 285$$

$$\log 15^{3x} = \log 285 \quad \text{Take the logarithm of each side.}$$

$$3x \log 15 = \log 285 \quad \text{Power Property of Logarithms.}$$

$$x = \frac{\log 285}{3 \log 15} \quad \text{Divide each side by } 3 \log 15 \text{ to isolate } x.$$

$$x \approx 0.6958 \quad \text{Use a calculator.}$$



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Got It? 2. a. What is the solution of $5^{2x} = 130$?

Exponential and Logarithmic Equations



Got It? 3. What is the solution of each exponential equation? Check your answer.

a. $7^{4x} = 800$

b. $5.2^{3x} = 400$

Exponential and Logarithmic Equations

Solve the equations.

A $10 = 5e^{4x}$

$$10 = 5e^{4x}$$

Original equation

$$2 = e^{4x}$$

Divide both sides by 5.

$$\ln 2 = 4x$$

Rewrite in logarithmic form.

$$\frac{\ln 2}{4} = \frac{4x}{4}$$

Divide both sides by 4.

$$\frac{\ln 2}{4} = x$$

Simplify.

$$0.173 \approx x$$

Evaluate. Round to three decimal places.

B $6^{3x} = 12$

$$\log 6^{3x} = \log 12$$

$$3x \log 6 = \log 12$$

$$x = \frac{\log 12}{3 \log 6} \approx 0.462$$

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Solve the equations.

Ⓒ $6^{3x-9} - 10 = -3$

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Problem 5 Solving a Logarithmic Equation

What is the solution of $\log (4x - 3) = 2$?

$$4x - 3 = 10^2$$

Write in exponential form.

$$4x = 103$$

Simplify.

$$x = \frac{103}{4} = 25.75 \quad \text{Solve for } x.$$

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Got It? 5. What is the solution of $\log (3 - 2x) = -1$?

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Got It? 6. What is the solution of $\log 6 - \log 3x = -2$?

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Problem 6 Using Logarithmic Properties to Solve an Equation

What is the solution of $\log(x - 3) + \log x = 1$?

$$\log((x - 3)x) = 1 \quad \text{Product Property of Logarithms}$$

$$(x - 3)x = 10^1 \quad \text{Write in exponential form.}$$

$$x^2 - 3x - 10 = 0 \quad \text{Simplify to a quadratic equation in standard form.}$$

$$(x - 5)(x + 2) = 0 \quad \text{Factor the trinomial.}$$

$$x = 5 \quad \text{or} \quad x = -2 \quad \text{Solve for } x.$$



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ANY QUESTIONS

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Classwork:

Worksheet 16-2

#13 - 24

**Write your answer as a
fraction**



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Solve each equation.

1. $8^{2x} = 32$ $\frac{5}{6}$

2. $7^n = 343$ 3

3. $9^{2x} = 27$ $\frac{3}{4}$

Solve each equation. Round answers to the nearest hundredth.

7. $5^{2x} = 20$ 0.93

8. $8^{n+1} = 3$ -0.47

9. $4^{n-2} = 3$ 2.79

Solve each equation. Check your answers.

13. $\log x = 2$ 100

14. $\log 4x = -1$ $\frac{1}{40}$

15. $\log 3x = 2$ $\frac{100}{3}$

19. $\log x - \log 4 = 3$ 4000

20. $\log x - \log 4 = -2$ $\frac{1}{25}$

21. $2 \log x - \log 4 = 2$ 20