

# Solving Exponential Equations & Change of Base

Algebra Worksheet · Grade 10–12

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

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

## Learning Objectives

- Apply logarithms to both sides of an exponential equation to solve for an unknown exponent
- Use the power property of logarithms to bring exponents down as coefficients
- Apply the change of base formula to evaluate logarithms with non-standard bases using a calculator

## Problems

1. Use the change of base formula to rewrite the following logarithm as a ratio of common logarithms (base 10).

$$\log_5 25$$

2. Use the change of base formula to evaluate the following logarithm. Round to three decimal places.

$$\log_4 50$$

3. Solve the exponential equation for x by taking the logarithm of both sides.

$$3^x = 81$$

4. Solve the exponential equation for x. Round your answer to three decimal places.

$$5^x = 30$$

5. Solve the exponential equation for x. Round your answer to three decimal places.

$$7^{3x} = 20$$

6. Use the change of base formula to evaluate the following logarithm. Round to four decimal places.

$$\log_3 15$$

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7. Solve the exponential equation for  $x$ . Round your answer to three decimal places.

$$4^{2x} = 100$$

8. Given that  $\log$  base 3 of 15 is approximately 2.4650, convert the logarithmic equation to exponential form and solve for  $x$ .

$$\log_2 x = 2.4650$$

9. Solve the exponential equation for  $x$ . Round your answer to three decimal places.

$$6^{x+1} = 50$$

10. Solve the exponential equation for  $x$ . Round your answer to three decimal places.

$$5^{2x-3} = 8^{x+1}$$

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# Solving Exponential Equations & Change of Base — Answer Key

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## Answer Key

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### 1. Answer: $\log(25) / \log(5) = 2$

- Apply change of base:  $\log_5(25) = \log(25) / \log(5)$
- Evaluate:  $\log(25) / \log(5) = 1.39794 / 0.69897 = 2$

### 2. Answer: $\approx 2.822$

- Apply change of base:  $\log_4(50) = \log(50) / \log(4)$
- Evaluate:  $1.69897 / 0.60206 \approx 2.822$

### 3. Answer: $x = 4$

- Take log of both sides:  $\log(3^x) = \log(81)$
- Apply power property:  $x \cdot \log(3) = \log(81)$
- Divide both sides by  $\log(3)$ :  $x = \log(81) / \log(3) = 4$

### 4. Answer: $x \approx 2.113$

- Take log of both sides:  $\log(5^x) = \log(30)$
- Apply power property:  $x \cdot \log(5) = \log(30)$
- Solve:  $x = \log(30) / \log(5) = 1.47712 / 0.69897 \approx 2.113$

### 5. Answer: $x \approx 0.513$

- Take log of both sides:  $\log(7^{3x}) = \log(20)$
- Apply power property:  $3x \cdot \log(7) = \log(20)$
- Divide by  $\log(7)$ :  $3x = \log(20) / \log(7)$
- Divide by 3:  $x = \log(20) / (3 \cdot \log(7)) \approx 1.30103 / (3 \cdot 0.84510) \approx 0.513$

### 6. Answer: $\approx 2.4650$

- Apply change of base:  $\log_3(15) = \log(15) / \log(3)$
- Evaluate:  $1.17609 / 0.47712 \approx 2.4650$

### 7. Answer: $x \approx 1.661$

- Take log of both sides:  $\log(4^{2x}) = \log(100)$
- Apply power property:  $2x \cdot \log(4) = \log(100)$
- $\log(100) = 2$ , so  $2x \cdot \log(4) = 2$
- Solve:  $x = 2 / (2 \cdot \log(4)) = 1 / \log(4) \approx 1 / 0.60206 \approx 1.661$

### 8. Answer: $x \approx 5.521$

- Convert to exponential form:  $x = 2^{2.4650}$
- Evaluate using a calculator:  $x = 2^{2.4650} \approx 5.521$

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**9. Answer:  $x \approx 1.228$**

- Take log of both sides:  $(x + 1) \cdot \log(6) = \log(50)$
  - Solve for  $(x + 1)$ :  $x + 1 = \log(50) / \log(6) = 1.69897 / 0.77815 \approx 2.228$
  - Subtract 1:  $x \approx 2.228 - 1 = 1.228$
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**10. Answer:  $x \approx 10.175$**

- Take log of both sides:  $(2x - 3) \cdot \log(5) = (x + 1) \cdot \log(8)$
  - Expand:  $2x \cdot \log(5) - 3 \cdot \log(5) = x \cdot \log(8) + \log(8)$
  - Collect x terms:  $x(2 \cdot \log(5) - \log(8)) = \log(8) + 3 \cdot \log(5)$
  - Substitute values:  $2(0.69897) - 0.90309 = 0.49485$ ;  $\log(8) + 3 \cdot \log(5) = 0.90309 + 2.09691 = 3$
  - Solve:  $x = 3 / 0.49485 \approx 10.175$
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