

2.8 Logarithmic Equations and Models

Standards:

FCR.3.5

Create and interpret logarithmic equations in one variable and use them to solve problems.

FCR.3.7

Create, interpret, and solve logarithmic equations in two or more variables to represent relationships between quantities.

Notes and Definitions

logarithmic equation: equation that has a variable within the argument of a log.

To solve a logarithmic equation, do the following:

- (1) Condense into a single logarithm or isolate the lone logarithm if necessary.
- (2) Change to exponential form.
- (3) Solve.

To find the acidity or alkalinity of a substance, the formula below can be used:

$$pH = -\log(H^+)$$

pH → potential of hydrogen

H^+ → molar hydrogen ion concentration

pH can range from 0 to 14 where 0 is extremely acidic, 7 is neutral, and 14 is extremely basic or alkaline.

The magnitude of earthquakes can be found with the formula:

$$M = \log\left(\frac{I}{S}\right)$$

M → magnitude of the earthquake

I → intensity measured a certain distance from the epicenter

S → intensity of a standard or very weak earthquake

Worked out examples

(1) Solve for x :

$$\log_3(x) - \log_3(3) = 4$$

$$\log_3\left(\frac{x}{3}\right) = 4$$

(Condense)

$$2^x = \frac{x}{3}$$

(Change to exponent form)

$$16 = \frac{x}{3}$$

(Evaluate the left)

$$3 \cdot 16 = 3 \cdot \frac{x}{3}$$

(Multiply both sides by 3)

$$48 = x$$

(2) A certain acidic solution has a hydrogen ion concentration of $H^+ = 3.2 \times 10^{-4}$ mol/L. Find the pH.

$$pH = -\log(H^+)$$

$$pH = -\log(3.2 \times 10^{-4})$$

$$pH \approx 3.49$$

The solution is somewhat acidic according to its pH.

(3) An earthquake releases energy such that the intensity measured at a location is 1=50000 units. If the reference intensity is 1 unit, what is the magnitude of the earthquake?

$$M = \log\left(\frac{I}{S}\right)$$

$$M = \log\left(\frac{50000}{1}\right)$$

$$M \approx 4.7$$

Examples to work out with the teacher

(1) Solve for x : $5 \cdot \log_3(x - 5) - 4 = 16$

(2) Solve for x : $\ln 18 + \ln x = 3$

(3) Find the pH of a substance that has a hydrogen ion concentration of 1.5×10^{-4} mol/L. Is the substance more acidic or alkaline?

(4) A substance is very alkaline with a pH of exactly 13. Find the hydrogen ion concentration of this substance rounded to two significant figures in scientific notation.

(5) Measured from a particular distance from the epicenter, an intensity of 80,000 units was recorded for an earthquake. If the reference intensity is 2 units, find the magnitude of the earthquake.

Student Independent Examples

Solve for x in the following logarithmic equations. (#1-8)

(1) $\log_3(x + 1) = 2$

(2) $\log_3(x + 5) = 3$

(3) $\log(2x) = 5$

(4) $\log x + \log 2 = 1$

(5) $\log_3 x - 2\log_3 2 = 4$

(6) $5\log_3(2x - 5) = 2$

(7) $8\ln(3x + 4) - 9 = 13$

(8) $\ln(3x - 1) = 5$

Use the formula $pH = -\log(H^+)$ to answer the following. (#9-14)

(9) A solution has a hydrogen ion concentration of $H^+ = 2.5 \times 10^{-4}$ mol/L. Find the pH of the solution. Round to the nearest hundredth.

(10) A soda has a pH of 3.8. Find the hydrogen ion concentration rounded to two significant figures in scientific notation.

(11) Which solution is more acidic: Solution A with $H^+ = 6.3 \times 10^{-4}$ mol/L or Solution B with $H^+ = 1.8 \times 10^{-4}$ mol/L. Calculate the pH and explain your answer.

(12) A solution has a pH of 5. What is the value of H^+ in scientific notation.

(13) Find the pH of a solution where $H^+ = 7.9 \times 10^{-4}$ mol/L. Round to the nearest tenth.

(14) A solution's pH drops from 6 to 4. By what factor does the hydrogen ion concentration increase?

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David Baud



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