

Unit 4 Lesson 18: Applications of Logarithmic Functions

1 Scrambled Logs (Warm up)

Student Task Statement

Without using a calculator, put the following expressions in order, from least to greatest. Be prepared to explain your reasoning.

$$\log 11 \quad \log_2 8 \quad \log_5 0.2 \quad \log 0.01 \quad \ln 1$$

2 How Acidic Is It? (Optional)

Student Task Statement

The pH scale is a way to measure the acidity of a liquid solution. It is based on the concentration of positive hydrogen ions in the liquid. A smaller pH indicates more hydrogen ions and higher acidity. A larger pH indicates less hydrogen ions and lower acidity.

Here is a table showing the hydrogen ion concentration (in moles per liter) and the pH of some different liquids:

liquids	hydrogen ion concentration (moles per liter)	pH
water	10^{-7}	7
coffee	10^{-5}	
root beer	10^{-4}	
orange juice	10^{-3}	
seawater		
vinegar		

1. Which of the drinks listed, water, coffee, root beer, or orange juice, is the most acidic? Which is the least acidic? Explain how you know.
2.
 - a. Seawater has a pH of 8. Is it more acidic or less acidic than water? Record the hydrogen ion concentration of seawater in the table.
 - b. Vinegar has a pH of 2.4. Is it more acidic or less acidic than orange juice? Record the hydrogen ion concentration of vinegar in the table.
3. A logarithm is used to translate hydrogen ion concentrations to pH values. With a partner, discuss how the hydrogen ion concentrations might be related to the pH. Use words or expressions to describe the relationship you notice.

3 pH Ratings (Optional)

Student Task Statement

This table shows the relationship between hydrogen ion concentrations and pH ratings (acidity) for different substances.

substance	hydrogen ion concentration (moles per liter)	pH
mild detergent	0.0000000001	10
toothpaste	0.000000001	9
baking soda	0.00000001	8
blood	0.0000001	7
milk	0.000001	6
banana	0.00001	5
tomato	0.0001	4
apple	0.001	3
lemon	0.01	2

1. Write an equation to represent the pH rating, p , in terms of the hydrogen ion concentration h , in moles per liter.
2. Test your equation by using the hydrogen ion concentration of a substance from the table as the input. Does it produce the right pH rating as the output? If not, revise your equation and test it again.
3. Magnesium hydroxide (also called "milk of magnesia") is a medication used to treat stomach indigestion. It has a hydrogen concentration 5.6×10^{-11} mole per liter. Estimate a pH rating for magnesium hydroxide. Explain or show your reasoning.
4. As shown in the table, apple has a pH of 3 and milk has a pH of 6. How many times more acidic is the apple than milk?

4 Measuring Earthquake Strength (Optional)

Student Task Statement

Here is a table showing the Richter ratings for displacements recorded by a seismograph 100 km from the epicenter of an earthquake.

seismograph displacement (meters)	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^0	10^1
Richter rating	1	2	3	4	5	6	7	8

1. Compare an earthquake rated with a magnitude of 5 on the Richter scale and that rated with a 6. How do their displacements compare? What about an earthquake with a magnitude rated with a 2 and that rated with a 3?
2. Discuss with a partner how the displacement might be related to the Richter scale. Express that relationship in words or with an expression.
3. An earthquake shook the northwest part of Indonesia in 2004, causing massive damage and casualties. If a seismograph was located 100 km from the epicenter, it would have recorded a displacement of 125 m! Use your answer to the previous question to estimate the Richter rating for the earthquake.