6.5 Making Connections: Logarithmic Scales in the Physical Sciences

Student Text Pages
349 to 355

Suggested Timing
75 min

Tools
- graphing calculator

Related Resources
- BLM 6–6 Section 6.5 Practice
- BLM 6-7 Section 6.5 Achievement Check Rubric

Teaching Suggestions

- The important thing for students to realize in this section is that logarithmic scales are useful for making easy comparisons in relationships in which the dependent variable changes over several orders of magnitude. The pH scale introduced in **Example 1** is a very common example that many students either will have encountered or will soon encounter in their chemistry class. Part d) is extremely important as it illustrates the key feature of this logarithmic scale: in increase of 1 on the pH scale corresponds to a *tenfold* increase in hydronium concentration.
- **Example 2** provides another, slightly more complex, commonly encountered logarithmic scale: the decibel scale, which is used for comparing sound intensities. This may be of particular interest to future students of the recording industry. It should be noted that the given examples are approximations and can vary depending on certain physical parameters, such as distance from the sound and variations in the source of the sound.
- The Richter scale introduced in **Example 3** provides a means to compare the intensities of earthquakes. In this situation, a reference value, I_0, is used, which represents the lowest intensity earthquake that is detectable.
- The **Communicate Your Understanding** questions are intended to help gauge students' understanding of the nature of a logarithmic scale and its usefulness. For C2, students should be encouraged to review the graphic scale that is shown on page 349.
- For **questions 1** through **5**, some students may need to review scientific notation.
- **Question 5** requires reflection and reasoning in order to communicate an understanding of the window settings of the graphing calculator. Connecting skills will then be necessary to read from the graph and verify the result found in part b).
- As a hint to **question 5**, have students consider that hydronium concentration is the independent variable and pH is the dependent variable. Some systematic trial may be required.
- For **questions 9** through **11**, add to or modify using more locally relevant data, typically available online.
- **Questions 12** through **16** should be of particular interest to future students of astronomy or physics. It should be noted that, unlike for the pH scale, a unitary difference on the stellar magnitude scale represents a difference in luminosity by a factor of approximately 2.5, not 10. The differences between apparent stellar magnitude, m, and absolute stellar magnitude, M, should be discussed (the latter factors out the distance variable). In **question 15**, for example, the absolute magnitude would be of greater interest to the astronomer as it provides relative information about the size and luminosity of the star, whereas the apparent magnitude does not, as varying distances from the observer tend to distort these observable properties.
- **Question 16** allows students to select tools with which to do research in order to learn about earthquakes. Reflecting on the elements researched and reasoning out the issues related to earthquakes are then communicated in a report.
- Go to *www.mcgrawhill.ca/books/functions12* and follow the links to find several websites for **questions 16** through **18**.
- Use **BLM 6–6 Section 6.5 Practice** for remediation or extra practice.

Differentiated Instruction

Use **four corners** to reinforce this section.

Ongoing Assessment

Achievement Check, question 13, on student text page 354.

Communicate Your Understanding Responses (page 353)

C1. a) Answers may vary. Sample answer: Situations where a variable ranges over several powers of 10.

b) Answers may vary. Sample answer: To make it easer to compare a vast range of quantities.

C2. Answers may vary. Sample answer:
Acidic pH: 1–5; neutral pH: 6–8; alkaline pH: 9–14

C3. No, a whisper is 100 times as intense as the rustle of leaves.

Mathematical Process Expectations

Process Expectation	Selected Questions
Problem Solving	
Reasoning and Proving	5, 13–18
Reflecting	13–18
Selecting Tools and Computational Strategies	16–18
Connecting	1–18
Representing	5
Communicating	3, 5–7, 9–18

Achievement Check, question 13, student text page 354

This performance task is designed to assess the specific expectations covered in section 6.5.

The following Math Process Expectations can be assessed.

- Problem Solving
- Reasoning and Proving
- Reflecting
- Selecting Tools and Computational Strategies
- Connecting
- Representing
- Communicating

Achievement Chart Category	Related Math Processes
Knowledge and Understanding	Selecting tools and computational strategies
Thinking	Problem solving, Reasoning and proving Reflecting
Communication	Communicating, Representing
Application	Selecting tools and computational strategies Connecting

Sample Solution

Provide students with **BLM 6-7 Section 6.5 Achievement Check Rubric** to help them understand what is expected.

a) $M_2 - M_1 = -9.5$

$\frac{b_1}{b_2} = 10^{-9.5}$ or $\frac{b_2}{b_1} = 109.5$

Betelgeuse is 3.16×10^9 times brighter than Sirius in absolute terms.

b) The answer to question 12 a) is that Sirius appears to be 41.68 times brighter than Betelgeuse. This suggests that Sirius is much closer to Earth so that it seems brighter because of its closeness.