Online modules for quantitative skill building: Exploring adaptation and adoption

Exponents and Logarithms Module

Some larger questions that the module addresses:

- How are exponential and logarithmic functions related to each other?
- How do logarithmic and exponential functions help us work with large numbers and put them into context?
- What types of real-world systems are modeled by exponential and logarithmic functions?

Specific skills. Students will be able to:

- Manipulate algebraic expressions that involve exponents and logarithms.
- Interpret graphs involving exponential or logarithmic functions.
- Use logs/exponents to analyze the number of steps in algorithms.
- Work with different bases. (Most common -- base 10, base e, and base 2. Others that we should consider?)

Application Problem Topics

- Computer Science - Binary Sort
- Economics - Estimating the Time for an Investment Asset to Double in Value
- Geoscience - Earthquakes and the Richter scale
- Chemistry - Radioactive Materials rate of decomposition
- Neuroscience - Perception of sound

What does an application question usually include?

- An application question begins by providing any needed context for someone who is not familiar with the discipline.
- For any application topic, there are usually 3-5 accompanying questions. The questions should either be multiple choice or numeric so that students can get immediate feedback.
- Faculty feedback in the initial conversations suggested there is interest in having both calculation/manipulation questions and conceptual questions.

Please use http://bit.ly/QLABContentSubmission to submit a question to add to this group!

Example Problem
Chemistry - Radioactive Materials rate of decomposition

Radioactive radon from natural sources can seep into the basement of homes. The major health hazard from radon, when it is inhaled by humans, arises not from radon itself but from its radioactive decomposition product, polonium, that can seriously damage lung tissues. Radon, as all radioactive materials, decomposes following an exponential decay. The equation is

$$ln(\frac{[Ra]_t}{[Ra]_o}) = -k\,t$$

where t is time, $[Ra]_t$ is the concentration of radon at time t, $[Ra]_o$ is the initial concentration of radon and k is the reaction rate constant. For radon, k is 0.18 day^{-1} (this value corresponds to this particular reaction and it does not depend on concentration).

1) Does the Ra concentration in a container that initially contains 0.200 mol/L of radon increase or decrease with time?
   Increase
   Decrease

2) A container is prepared in which the initial concentration of Ra is 0.200 mol/L. What is the concentration of Ra at 1 day, 4 days and 30 days? (Round your answer to the third decimal place.)
   1 day _____ mol/L
   4 days_____mol/L
   30 days_____mol/L)

3) Are your answers in 1 and 2 consistent?
   Yes
   No

4) A container is prepared in which the initial concentration of Ra is 0.500 mol/L. How many days would it take for the concentration of Ra to become 0.250mol/L? (Round your answer to the second decimal place)
   _____ days
   Since this time is the time it takes for half the amount of initial substance to disappear we call this time the half-life of radon (its symbol is $t_{1/2}$)

5) ^{131}I is another radioactive element. It is used to treat thyroid disease -- patients whose thyroids produce more hormones than is healthy are treated by having them consume ^{131}I, which deposits in the thyroid gland and subsequently destroys the gland. Like all radioactive elements its decay is a first order process. A sample is prepared containing 0.010mol/L of ^{131}I. It only takes 0.086 days for the ^{131}I concentration to become 0.005mol/L. What is the rate constant for the radioactive decay of ^{131}I? (Round your answer to the second decimal place)
   _____$days^{-1}$