1. The Michaelis-Menton equation:

$$V = \frac{V_{\max} \cdot S}{S + K_m}$$

is used to predict the velocity of an enzymatic reaction where V is the velocity of the reaction, S is the concentration of the substrate, and $V_{\max}$ and K_m are positive constants where $V_{\max}$ represents the maximum possible velocity for the reaction. (20 points)

   a. If we think of V as a function of S, what is the domain of the function?
   $\boxed{S \neq -K_m \text{ or } S \geq 0}$ (2 points)
   b. Find the inverse of the equation/function (that is, solve the equation for S as a function of V).
   $\boxed{S = \frac{K_m \cdot V}{V_{\max} - V}}$ (12 points)
   c. What is the domain of this inverse function?
   $\boxed{V \neq V_{\max} \text{ or } 0 \leq V < V_{\max}}$ (2 points)
   d. At what substrate concentration will the velocity of the reaction be half the maximum possible?
   $\boxed{S = K_m}$ (4 points)

2. The following equation describes the relationship between Length (L) and Weight (W) for Pacific halibut:

$$W = 10.4L^3$$

(15 points)

   a. What type of equation is this?
   $\boxed{\text{allometric}}$ (3 points)
   b. Solve the equation for L as a function of W.
   $\boxed{L = \sqrt[3]{\frac{W}{10.4}}}$ (12 points)

3. The Richter scale is used to report the magnitude of earthquakes and is calculated using the following equation:

$$R = \log_{10}\left(\frac{A}{A_0}\right)$$

where R is the Richter Number, A is the amplitude of the earthquake, and A_0 is a positive constant that represents the smallest amplitude that can be detected by the seismograph. (20 points)

   a. Solve the equation for A as a function of R.
   $\boxed{A = A_0 \cdot 10^R}$ (12 points)
   b. This past year there was an earthquake in Pakistan that measured 5.6 on the Richter scale, and the tsunami that hit Southeast Asia (a little over a year ago) was triggered by an underwater earthquake that measured 9.0 on the Richter scale. How many times as strong was the amplitude of the Southeast Asia earthquake compared to the Pakistan earthquake?
   $\boxed{10^{3.4} \approx 2512}$ (8 points)

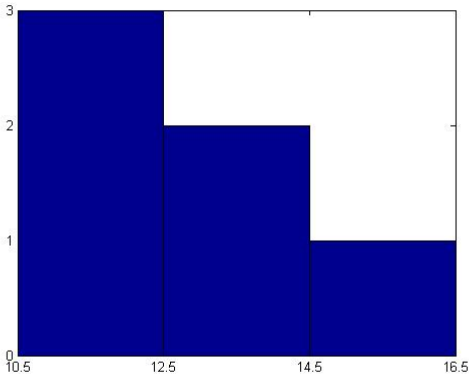
4. An entomologist is in the Smokies counting how many species of insects are found on different trees. After sampling 6 trees, she recorded the following data:

   12, 11, 16, 13, 14, 12

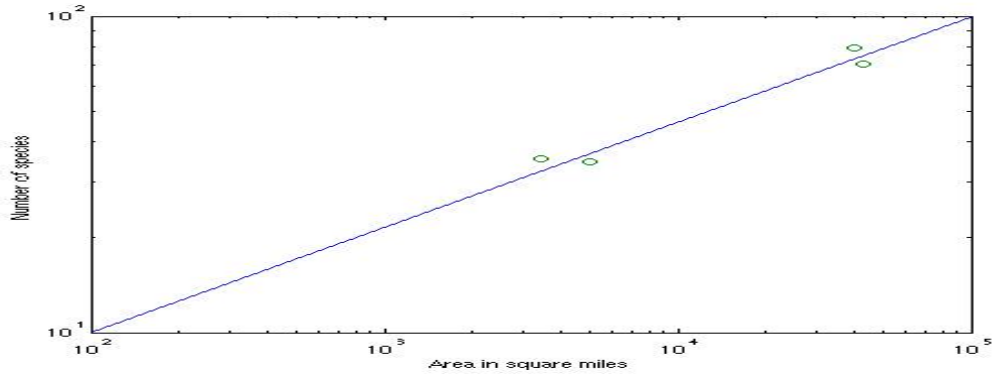
   Find the mean, median, mode, and standard deviation, and construct a histogram with 3 classes for this data set. (25 points)

$$\boxed{\begin{aligned} Mean &= 13 \\ Median &= 12.5 \\ Mode &= 12 \\ SD &= \sqrt{3.2} \approx 1.79 \end{aligned}}$$

(5 points for each part)



5. Below is a log-log graph of the Area (A) and the number of Species (S) of amphibians and reptiles for several islands in the West Indies along with a least-squares regression line that describes the relationship between the two. (25 points)



   a. Find the equation for the least-squares regression line. (Don't calculate it. Just figure it out from the graph.)

   $\boxed{y = \frac{1}{3}x + \frac{1}{3}}$ (10 points)

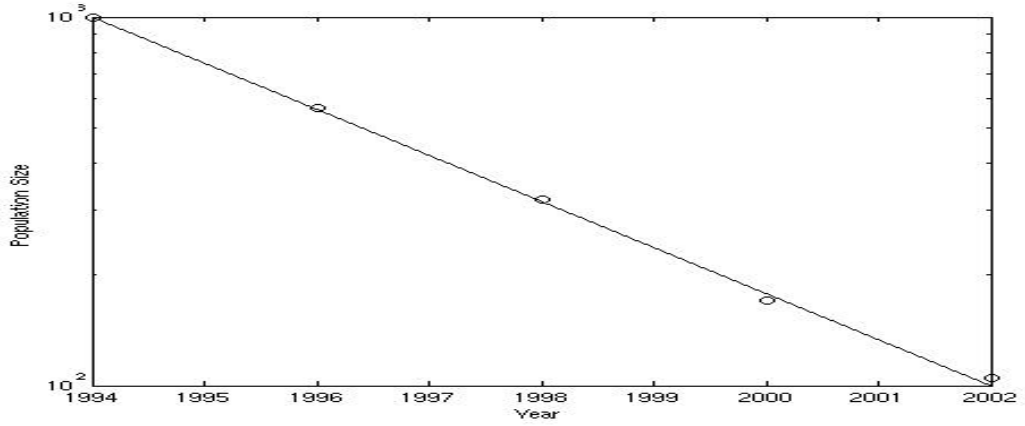
   b. Use the least-squares regression line to find an Area-Species equation that describes the relationship (that is, find S as a function of A).

   $\boxed{S = 10^{\frac{1}{3}} A^{\frac{1}{3}} \approx 2.15A^{\frac{1}{3}}}$ (10 points)

   c. There are two small islands in the West Indies nearby each other. The first island is eight times the area of the second island. If the Area-Species equation holds for both of these islands, how many times as many species of amphibians and reptiles should we expect to find on the larger island compared to the smaller island?

   $\boxed{2}$ (5 points)

6. Below is a semi-log graph that plots the size of a population of coyotes that is declining due to habitat loss along with a least-squares regression line. (HINT: Let $t = 0$ stand for 1994.) (25 points)



   a. Find the equation for the least-squares regression line. (Don't calculate it. Just figure it out from the graph.)
   $\boxed{y = -\frac{1}{8}x + 3}$ (10 points)
   b. Use the least-squares regression line to find an exponential decay function for the population size, $N(t)$, as a function of time, t.
   $\boxed{N(t) = 1000 \cdot 10^{-t/8}}$ (10 points)
   c. If the population size declines to one, it will go extinct (because that one coyote can't reproduce on its own). If the population continues to decline according to the exponential decay function, in what year will the population size be one.
   $\boxed{2018 \text{ or } t = 24}$ (5 points)

7. Radioactive Strontium 90 is potentially very dangerous to humans. If deposited into pasture land by "acid rain," it will eventually make its way into plants and into the milk of cows who graze there. About 3% of the Strontium 90 entering the human body becomes a permanent part of bone tissue, where its radioactivity could cause cancer. The Strontium 90 level in a certain field has been determined to be three times the safe level. If the half-life of Strontium 90 is 29 years, how many years will it take before the pasture can be used again for grazing? (20 points)

$$\boxed{t = \frac{\ln \frac{1}{3}}{\left(\ln \frac{1}{2}\right)/29} \approx 46 \text{ years}}$$

BONUS:

Sound intensity level is measures in decibels (dB) and is calculated using the following formula:

$$dB = 10 \cdot \log_{10}\left(\frac{I}{I_0}\right)$$

where I is the intensity of the sound, and I_0 is a positive constant that represents the threshold of human hearing. If the sound of a single mosquito buzzing registers as 0 dB, how many decibels is the sound of 1000 mosquitoes buzzing? (10 points)

$\boxed{30\ dB}$