3. [14 points] At a wildlife sanctuary in central Africa, conservationists are carefully monitoring the population of various species of animals. For the following parts, write your answers in the spaces provided. Your answers for this problem can either be exact, or accurate to three decimal places.

a. [3 points] On January 1, 2008, the population of lions in the sanctuary was estimated to be 850, and was decreasing exponentially at a continuous rate of 25% each year. Find a formula for the population \( L(t) \) of lions in the sanctuary \( t \) years after January 1, 2008. You do not need to show any work for this part.

\[
L(t) = 850e^{-0.25t}
\]

b. [5 points] On the other hand, the number of elephants in the sanctuary increased by 60% every 7 years. Let \( E(t) \) be the number of elephants in the sanctuary \( t \) years after January 1, 2008. What is the (annual) continuous growth rate of the function \( E \)? You should carefully show your work for this part.

**Solution:** The function \( E(t) \) is exponential, so we have \( E(t) = ae^{kt} \) for some constants \( a \) and \( k \). We know that \( E(7) = 1.6a \), so:

\[
1.6a = ae^{7k}
1.6 = e^{7k}
7k = \ln 1.6
k = \frac{7}{7} \ln 1.6
\]

The continuous growth rate of \( E \) is \( \frac{\ln(1.6)}{7} \) per year.

For the following parts, you do not need to show any work, but you can receive partial credit for work shown if your final answer is incorrect.

c. [3 points] Let \( B(m) = 60(3)^{0.5m-1} \) be the number of buffalo in the sanctuary \( m \) months after July 15, 2016. What is the (monthly) continuous growth rate of the function \( B \)?

The continuous growth rate of \( B \) is \( \ln(3^{0.5}) \) per month.

d. [3 points] Let \( H(y) \) be the total value of donations received by the sanctuary’s governing organization (in thousands of dollars) \( y \) years after July 15, 2016. The function \( H \) is exponential, with continuous growth rate \( e^{0.77} \). What is the annual percentage growth rate of the function \( H \)?

The annual percentage growth rate of \( H \) is \( e^{(0.77)} - 1 \)