Do the following problems and write answers in the space provided. If writing a sentence, use complete, correct English sentences. Show important algebraic steps. When appropriate, partial credit can be given only if the steps and work are clearly shown.

1. A pond has a population of 500 frogs. Over a ten-year period the number \( N \) of frogs depends on the year \( t \) as indicated in the following graph.

   Interpret, in the context of this problem, the meaning of the horizontal and vertical intercepts. Include appropriate units. (4 pts. each)
   
   i) horizontal intercept:

   ii) vertical intercept:

2. The temperature \( H \), in degrees Celsius, of a cup of coffee placed on the kitchen counter is given by \( H = f(t) \), where \( t \) is minutes since the coffee was put on the counter. (4 pts. each),

   a) Interpret, in the context of this problem, the meaning of \( f(3) = 20 \).
      Include appropriate units in your answer.

   b) Interpret, in the context of this problem, the meaning of \( f'(3) = -2 \).
      Include appropriate units in your answer.

3. The average weight, in pounds, of American men in their sixties is a linear function of their heights, in inches, that is, \( w = f(h) \). Data is given below. (The data was collected in 1979.)

<table>
<thead>
<tr>
<th>height ( h ), inches</th>
<th>68</th>
<th>70</th>
<th>73</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight ( w ), pounds</td>
<td>166</td>
<td>176</td>
<td>191</td>
</tr>
</tbody>
</table>

   a) Find the slope of this linear function. (4 pts.)

   \[ 3.a) \ m = \]

   b) Find a linear function for the weight \( w \) as a function of the height \( h \).
      Clearly show work. Use \( h \) & \( w \) not \( x \) & \( y \)! (4 pts.)

   \[ 3.b) \]

   c) Interpret, in the context of this problem, the meaning of the slope.
      Include appropriate units in your answer. (4 pts.)
4. A company that makes patio chairs has fixed costs of $5000 and variable costs (MC) of $30 per chair. The company sells the chairs for $50 each. Let q to represent the number of patio chairs made or sold. Assume all functions are linear
   a) Find the cost function C, the revenue function R and the profit function \( \pi \). (6 pts.)

\[
C = \\
R = \\
\pi = \\
\]

b) What is the break-even point, \( q_0 \), for this company? That is, how many patio chairs would have to be made and sold in order to begin to make a profit? (3 pts.)

b) \( q_0 = \) 

5. Values for three different functions are given below.

<table>
<thead>
<tr>
<th>t</th>
<th>f(t)</th>
<th>g(t)</th>
<th>h(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>12</td>
<td>16</td>
<td>37</td>
</tr>
<tr>
<td>0</td>
<td>17</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>36</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>54</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>81</td>
<td>25</td>
</tr>
</tbody>
</table>

a) i) Which of these functions could be linear? Clearly show or explain how you know.
   ii) Find a formula for this function. (4 pts.)

b) i) Which function could be exponential? Clearly show or explain how you know.
   ii) Find a formula for this function. (4 pts.)

   c) Is the remaining function: i) increasing or decreasing? ____________
      (2 pts. each)
   ii) concave up or concave down? ____________

6. Let \( P \) be the population of a town at year \( t \).
   a) If \( P = 1000e^{-0.06t} \), what is the continuous rate of growth or decay? (3 pts.)
      Include appropriate units in your answer.
       
       6. a) 

b) If instead this population increased by 50 people a year, what is the function \( P \)? (3 pts.)

b) 

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7. The population of Nicaragua was 3.6 million in 1990 and growing at 3.4% per year. Let \( P \) be the population, in millions, and let \( t \) be the years since 1990. (3 pts. each)
   a) Express \( P \) as a function in the form \( P = 3.6 a^t \).

   7.a) \( P = \) \\

   b) Convert \( P \) to a function of the form \( P = P_0 e^{kt} \).
      (Round \( k \) to 2 decimal places.)

   7.b) \( P = \) \\

8. The quantity \( Q \), in mg, of an antibiotic in a person's bloodstream \( t \) hours since the antibiotic was taken is described by \( Q = 250(0.6)^t \).
   a) What is the growth or decay rate? Include appropriate units. (3 pts.)

   8.a) \\

   b) What is an approximation of the instantaneous rate of change after \( t = 3 \) hours? Include appropriate units. (Hint: Use the interval \( t = 3 \) to \( t = 3.1 \)) (5 pts.)
      Round to one decimal place.

   8.b) \\

9. Refer to the graph of a function \( y = f(x) \) given below to determine if the following quantities are positive, negative or zero. (2 pts. each)

   \[ y = f(x) \]

   a) \( f(1) \) \\
   b) \( f'(0) \) \\
   c) \( f''(-1) \) \\

10. The following graph shows the height \( h \), in inches, of a bean plant \( t \) days after germination. What is the approximate growth rate (rate of change of \( h \) with respect to \( t \)) on the 15th day? Include appropriate units! (4 pts.)

   10) 

   (Graph showing height vs. days since germination with points (15, 11), (30, 25))
11. Given the following data about a function $f$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>3.0</th>
<th>3.2</th>
<th>3.4</th>
<th>3.6</th>
<th>3.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>8.2</td>
<td>9.5</td>
<td>10.5</td>
<td>11.0</td>
<td>13.2</td>
</tr>
</tbody>
</table>

a) What is the total change in $f$ between $x = 3.2$ and $x = 3.8$  
(2 pts.)

b) Find the average rate of change of $f$ between $x = 3.2$ and $x = 3.8$  
(4 pts.)

c) Estimate $f'(3.2)$. (Use an interval to the right)  
(5 pts.)

d) Estimate the slope of the tangent line at $x = 3.4$. (Use an interval to the right)  
(5 pts.)

12. On the given axes, sketch the graph of the derivative of the following function $y = f(x)$.  
(5 pts.)

\[ y = f(x) \]

\[ y' = f'(x) \]