1. (33 points) EPA inspectors have taken a sample of murky lake water and placed it in a tube. They shine a light of known intensity at one end of the tube and place a light sensor at various depths down the tube. The depth $D$ is measured in cm and the intensity $I$ is measured as a fraction of full power; here are the results:

<table>
<thead>
<tr>
<th>$D$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I$</td>
<td>.912</td>
<td>.560</td>
<td>.344</td>
<td>.211</td>
<td>.130</td>
</tr>
</tbody>
</table>

a. What is the average rate of change of $I$ from $D = 1$ to $D = 4$?

b. Demonstrate clearly that $I$ can not be a linear function of $D$.

c. Assume that $I$ is a discrete exponential function of $D$ (due to different sediments at different depths). Give a formula for $I$ as a function of $D$. You must use, in one way or another, all the values given in the table.

d. Predict the value of $I$ for $D = 3.5$ cm to three decimal places.
2. (10 points) Using the graph of \( r = f(p) \), given below, which variable is the dependent variable? 

Determine the average rate of change (to two decimal places) from \( p = 0 \) to \( p = 3 \) and from \( p = 4 \) to \( p = 6 \). At which value of \( p \) is \( f(p) \) the greatest?

3. (15 points) The amount of caffeine in a cup of coffee at time \( t \) is \( A(t) = A_0e^{rt} \), where \( A_0 \) is the initial amount. The half-life of caffeine in the body is about 4 hours. What is the “decay rate” \( r \) of the caffeine in the body? How long will it take for the level to fall by 75% of the original amount (hint: what per cent will remain)?

4. (8 points) The carrying capacity \( M \) is the maximum number of squirrels that can live on the Horseshoe successfully. The growth rate \( G \) of the population of squirrels on the Horseshoe is proportional to the product of the number of squirrels \( N \) and the difference between \( N \) and the carrying capacity \( M \). Write the formula that gives \( G \) in terms of \( M \) and the present population \( N \).
5. (12 points) Assume $s$ is a linear function of $t$, with the following values.

<table>
<thead>
<tr>
<th>$s$</th>
<th>10</th>
<th>6</th>
<th>0</th>
<th>$-6$</th>
<th>$-7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$</td>
<td>-2</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

a. Which is the **independent** variable?  

b. The slope is $m =$  

c. Fill in the missing values, and find the formula for $s$ as a function of $t$.

d. Write $t$ as a linear function of $s$.

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6. (15 points) A company that makes ceiling fans has fixed costs of $9000 for a certain product line and variable costs of $50 per fan. The company plans to sell these fans for $80 each. Let $q$ represent the number of fans. Give formulas for the cost function $C(q)$ and the revenue function $R(q)$. What is the break-even point in terms of number of fans?
7. (7 points) The table below gives the concentration $C(t)$ of carbon dioxide (CO$_2$) in parts per million (ppm) in the atmosphere since 1960. Determine and fill in an appropriate scale for $t$. Use your calculator’s curve-fitting or regression package to find the best exponential fit for this data, and give the formula. Then use the formula or your graph to estimate the amount of CO$_2$ in the atmosphere the year 2000.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C(t)$</td>
<td>316.8</td>
<td>319.9</td>
<td>325.3</td>
<td>331.0</td>
<td>338.5</td>
<td>345.7</td>
</tr>
</tbody>
</table>