1. Given that \( \frac{dP}{dt} = \sqrt{P} \) and \( P(0) = 100 \), use Euler's Method with \( \Delta t = 2 \) to obtain an estimate for \( P(10) \).

<table>
<thead>
<tr>
<th>( t )</th>
<th>( P )</th>
<th>( \frac{dP}{dt} = P^{1/3} )</th>
<th>( P_{\text{new}} \approx P + (\frac{dP}{dt}) \cdot \Delta t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>4.64</td>
<td>100 + 4.64(2)</td>
</tr>
<tr>
<td>2</td>
<td>109.28</td>
<td>4.78</td>
<td>109.28 + 4.78(2)</td>
</tr>
<tr>
<td>4</td>
<td>118.85</td>
<td>4.92</td>
<td>118.85 + 4.92(2)</td>
</tr>
<tr>
<td>6</td>
<td>128.68</td>
<td>5.05</td>
<td>128.68 + 5.05(2)</td>
</tr>
<tr>
<td>8</td>
<td>138.78</td>
<td>5.18</td>
<td>138.78 + 5.18(2)</td>
</tr>
<tr>
<td>10</td>
<td>149.13</td>
<td></td>
<td>( P(10) \approx 149.1 )</td>
</tr>
</tbody>
</table>

\( P(10) \approx 149.1 \)
2. Suppose that 200 rabbits are released on Lady Tottington’s estate, and that the population of these rabbits grows logistically with an intrinsic growth rate of 4% per month and a carrying capacity of 1000 rabbits.

(a) Let \( R \) represent the number of rabbits on her estate \( t \) months after the initial release. Determine a differential equation with initial condition to model this population of rabbits.

\[
\frac{dR}{dt} = 0.04R \left(1 - \frac{R}{1000}\right)
\]

\( R(0) = 200 \)

(b) Sketch a plausible graph for this population of rabbits.
3. The population of a town is currently 600, but is projected to grow by 30 people per year from now on.

(a) Determine a differential equation with initial condition to model this town's population. Use $P$ for the population $t$ years from now.

\[
\frac{dP}{dt} = 30
\]

$P(0) = 600$

(b) Find an explicit formula for this town's population.

$P = 30t + 600$
4. The population of a town $t$ years from now is given by $P$. Suppose that the population of the town is currently 400.

(a) Determine a mathematical model which best describes this town's population if it grows at a continuous rate of 8.5% per year.

\[ \frac{dP}{dt} = 0.085P \]

$P(0) = 400$

(b) Determine a mathematical model which best describes this town's population if it grows at an annual rate of 8.5% per year.

\[ P(n) = P(n-1) + 0.085P(n-1) \]

\[ = 1.085P(n-1) \]

$P(0) = 400$

(c) Find an explicit formula for $P$ using each of your models above and use it to predict the population 10 years from now.

(a) $P(t) = 400e^{0.085t} \Rightarrow P(10) \approx 936$

(b) $P(n) = 400(1.085)^n \Rightarrow P(10) \approx 904$
5. Suppose that the population of a town is always growing at a rate which is proportional to the population itself. Suppose further that the population is currently 500 and is growing at a rate of 25 people per year. Find a differential equation with initial condition to model the population of this town. Use $P$ for the population $t$ years from now.

\[ \frac{dP}{dt} = k \cdot P \]

\[ 25 = k \cdot 500 \]

\[ k = \frac{25}{500} = 0.05 \]

\[ \frac{dP}{dt} = 0.05P \]

\[ P(0) = 500 \]