1. Give the updating equation (also known as the recurrence equation) for the length \( \ell(n) \) of a chain of \( n \) grocery buggies, where each buggy is 4 feet long, and when you push a new buggy into the chain, only 6 inches sticks out. Note that the pattern doesn’t really begin until you actually have one buggy, so \( \ell(0) \) is not defined. \( \ell(1) = 4, \ell(2) = \frac{4.5}{\text{ft}} \), \( \ell(3) = \frac{5}{\text{ft}} \). Then find an explicit formula for \( \ell(n) \) in terms of \( n \). Suggestion: make a table with a column for \( n \) and a column for \( \ell(n) \).

\[
\ell(n+1) = \ell(n) + 0.5
\]

Chain gets \( \frac{1}{2} \) ft longer with each additional cart.

<table>
<thead>
<tr>
<th>( n )</th>
<th>( \ell(n) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>4.5 + 2(0.5)</td>
</tr>
<tr>
<td>3</td>
<td>5.0 + 3(0.5)</td>
</tr>
<tr>
<td>4</td>
<td>5.5 + 4(0.5)</td>
</tr>
<tr>
<td>5</td>
<td>6.0 + 5(0.5)</td>
</tr>
</tbody>
</table>

Now \( n \) carts is one cart (4 ft) plus \( n-1 \) handle lengths (0.5 ft each).

\[
\ell(n) = 4 + 0.5(n-1)
\]

2. If \( P(n) = n^2 - 3n \), compute \( \Delta P \).

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

\[
= [8(n+1)^2 - 3(n+1)] - [n^2 - 3n]
\]

\[
= n^2 + 2n + 1 - 3n - 3 - n^2 + 3n
\]

\[
= 2n - 2
\]