Falling Objects

A space shuttle depends on gravity to return to the Earth. Below an altitude of about 13 700 m, the descent of the shuttle is not powered. The shuttle's descent toward the runway is at an angle of 19° to the horizontal. This is much steeper than the 3° angle used for the powered descent of a commercial airliner.

In the Modelling Math questions on pages 191, 219, 232, and 242, you will solve the following problem and other problems that involve falling objects.

The approximate height above the ground of a falling object dropped from the top of a building is given by the function

\[ h(t) = -5t^2 + d \]

where \( h(t) \) metres is the height of the object \( t \) seconds after it is dropped, and \( d \) metres is the height from which it is dropped. The table shows the heights of three tall buildings in Canada.

<table>
<thead>
<tr>
<th>Building</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petro-Canada 1, Calgary</td>
<td>210</td>
</tr>
<tr>
<td>Two Bloor West, Toronto</td>
<td>148</td>
</tr>
<tr>
<td>Complexe G, Québec City</td>
<td>126</td>
</tr>
</tbody>
</table>

a) Write the three functions, \( f'(P\text{-C1}) \), \( f'(TBW) \), and \( f'(CG) \), that describe the height of the falling object above the ground \( t \) seconds after it is dropped from the top of each building.

b) Graph \( h(t) \) versus \( t \) for the three functions on the same set of axes or in the same viewing window of a graphing calculator.

c) How could you transform the graph of \( f'(P\text{-C1}) \) onto the graph of \( f'(TBW) \)?

d) How could you transform the graph of \( f'(CG) \) onto the graph of \( f'(TBW) \)?

e) How could you transform the graph of \( f'(P\text{-C1}) \) onto the graph of \( f'(CG) \)?

Use your research skills to answer the following questions now.

1. The velocity of a falling object increases until the object reaches a terminal velocity. The terminal velocity is not the same for all falling objects. What factors influence terminal velocity?

2. Aristotle believed that the heavier the object, the faster it would fall. Galileo disproved this theory. How did he do it?