



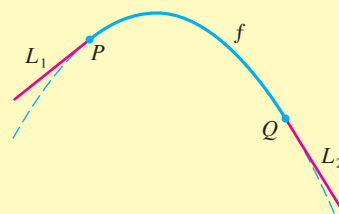
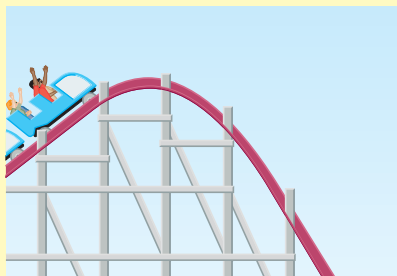
**DISCOVERY
PROJECT**


Designing a Roller Coaster

Suppose you are asked to design the first ascent and drop for a new roller coaster. By studying photographs of your favorite coasters, you decide to make the slope of the ascent 0.8 and the slope of the drop -1.6 . You then connect these two straight stretches $y = L_1(x)$ and $y = L_2(x)$ with part of a parabola

$$y = f(x) = ax^2 + bx + c$$

where x and $f(x)$ are measured in feet. For the track to be smooth there can't be abrupt changes in direction, so you want the linear segments L_1 and L_2 to be tangent to the parabola at the transition points P and Q , as shown in the figure.



1. To simplify the equations, you decide to place the origin at P . As a consequence, what is the value of c ?
2. Suppose the horizontal distance between P and Q is 100 ft. To ensure that the track is smooth at the transition points, what should the values of $f'(0)$ and $f'(100)$ be?
3. If $f(x) = ax^2 + bx + c$, show that $f'(x) = 2ax + b$.
4. Use the results of problems 2 and 3 to determine the values of a and b . That is, find a formula for $f(x)$.
5.  Plot L_1 , f , and L_2 to verify graphically that the transitions are smooth.
6. Find the difference in elevation between P and Q .