10. As shown in Figure 1.13, Freddy Flintstone wishes to drive his car with square wheels along a strange road. How should you design the road so that his ride is perfectly smooth, i.e., so that the center of his wheel travels in a horizontal line? (Hints: Start with a square with vertices at $(\pm 1, \pm 1)$, with center
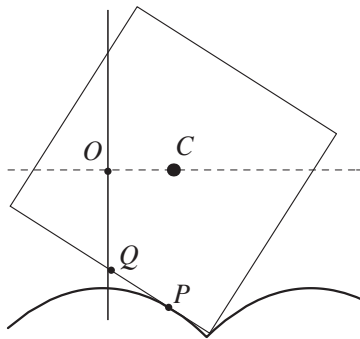

FIGURE 1.13

C at the origin. If $\boldsymbol{\alpha}(s) = (x(s), y(s))$ is an arclength parametrization of the road, starting at $(0, -1)$, consider the vector $\overrightarrow{OC} = \overrightarrow{OP} + \overrightarrow{PQ} + \overrightarrow{QC}$, where $P = \boldsymbol{\alpha}(s)$ is the point of contact and Q is the midpoint of the edge of the square. Use $\overrightarrow{QP} = s\boldsymbol{\alpha}'(s)$ and the fact that $\overrightarrow{QC}$ is a unit vector orthogonal to

$\overrightarrow{QP}$. Express the fact that C moves horizontally to show that $s = -\dfrac{y'(s)}{x'(s)}$; you will need to differentiate