Consider a particle of mass $m$ and angular momentum $\ell$ subject to a central force $F(r) = -V'(r)$ and moving in a stable circular orbit of radius $r = R$. Show that nearly circular orbits in the immediate vicinity have an apsidal angle

$$\Delta \vartheta = \pi \sqrt{\frac{V'(R)}{3V''(R) + RV'''(R)}}.$$ 

Solution: