Physics 701: Classical Mechanics

Thornton Hall 425, San Francisco State University  Fall 2015, MWF 5:10PM

Homework 6 Due 5:10PM 11/10

While I may have consulted with other students in the class regarding this homework, the solutions presented here are my own work. I understand that to get full credit, I have to show all the steps necessary to arrive at the answer, and unless it is obvious, explain my reasoning using diagrams and/or complete sentences.

Name ___________________________ Signature: ___________________________

1. (100 points) A central force potential frequently encountered in nuclear physics is the rectangular well, defined by the potential

\[ V(r) = 0 \] for \( r > a \)

\[ V(r) = -V_0 \] for \( r \leq a \)

Show that the scattering produced for such a potential in classical mechanics is identical with the refraction of light rays by a sphere of radius \( a \) and relative index of refraction

\[ n = \sqrt{\frac{E + V_0}{E}} \]

where \( E \) is the energy of the particle. (This equivalence demonstrates why it was possible to explain refraction phenomena using both particle and wave mechanics). Show also that the differential cross-section is

\[ \sigma(\theta) = \frac{n^2a^2 \left[ n \cos \left( \frac{\theta}{2} \right) - 1 \right] \left( n - \cos \frac{\theta}{2} \right)}{4 \left( 1 + n^2 - 2n \cos \frac{\theta}{2} \right)^2 \cos \frac{\theta}{2}} \]