J03M.1—Scattering from an Attractive Potential

Problem

This problem is about scattering by an attractive potential.

a)   Consider a particle with energy E and $z < 0$ approaching the $z = 0$ plane at an angle θ_1 to the z-axis. Find the angle θ_2 that it makes to the z axis after passing through the $z = 0$ plane if $V = 0$ for $z < 0$ and $V = -V_0$ (constant) for $z > 0$.

b)   Apply your result to a uniform beam of particles scattered by the attractive potential

$$V(r) = -V_0 \quad r < a, \qquad V(r) = 0 \quad r > a$$

Determine the differential cross section. (Recall that the definition of the differential cross section is $\frac{d\sigma}{d\Omega} = \frac{b}{\sin\theta}\frac{db}{d\theta}$, where b is the impact parameter and θ the scattering angle.)