CLASSICAL MECHANICS TFY4345 - Exercise 8

(1a) Find the differential cross section $\sigma(\Theta)$ for scattering against a hard sphere of radius a. The potential for this sphere can be written as $V \to \infty$ for $r < a$ and $V = 0$ for $r > a$. Find from this the total cross section σ. Why is the final expression for σ reasonable?

(1b) Suppose now that the scattering occurs in a central field where the central force $f = -dV/dr$ is repulsive and equal to $f = k/r^3$ $(k > 0)$. Show that in this case the formula

$$\Theta = \pi - 2\int_0^{u_m} \frac{s\,du}{\sqrt{1 - V(u)/E - s^2u^2}}, \tag{1}$$

where $u = 1/r$, yields the result

$$\sigma(\Theta) = \frac{k}{2\pi E}\frac{1-x}{x^2(2-x)^2\sin(\pi x)}, \text{ where } x = \Theta/\pi. \tag{2}$$

You may use that

$$\int \frac{dx}{\sqrt{1-x^2}} = \arcsin(x). \tag{3}$$

(1c) Explain in words the physical meaning of the differential scattering cross section and the total scattering cross section, accentuating the distinction between them.

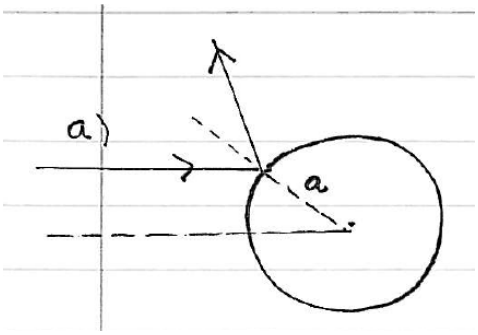

FIG. 1: (Color online). The system under consideration.